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ABSTRACT

This publication is designed to provide guidelines for future program management decisions and is based on data from three sources: research into the nature and development of emerging training programs and supply/demand relationship for technician occupations in the marine sciences; site visits with directors and staff of such training programs and with employers of their graduates; and workshops to allow and observe interaction between professionals closely associated with marine technician training. Four recommendations are presented, following an assessment of the data. Appendices include bibliographical data related to training program director workshops and marine technician training programs. Samples of training program curricula are presented. References are included. (Author/EB)

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Summary

MARINE TECHNICIAN TRAINING & EMPLOYMENT

A CURRENT OVERVIEW & ASSESSMENT

Leonard Mitchell
and Joel Goodman

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This work is a result of research sponsored by NOAA Office of Sea Grant, Dept. of Commerce, under Grant no. 04-3-158-30

REPORT
prepared for

The Interagency Committee on Marine Science and Engineering

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Summary

The history of marine technician training programs in the United States parallels to a great extent the history of national concern with imaginative and beneficial utilization of the nation's marine environment. Both are relatively recent phenomena.

There is little positive that can be said about marine technician training at this time and after many years of activity on the part of educators and sponsors, the need for, and value of marine technician training programs in the United States is still in question.

Spurred by the rhetoric of what appeared to be a concerted national effort to develop marine resources and by the interest of two-year institutions in offering students training for technician careers, the number of schools offering marine technician training has expanded from 1 to 34 since 1965.

Early in this brief period of continuing expansion, questions concerning the viability of further expansion were raised. Program planners searching for reliable manpower data from which to forecast future needs came up empty-handed. Accurate surveys prepared on a national scale were not available. Surveys compiled by polling local employers too often revealed a lack of "product" understanding on the part of industry. Funding and advice were made available from various government agencies, but due to compartmentalization of interests, no single federal agency could be relied upon to provide an overall picture of the marine technician training community.

In 1973, little seemed to have changed. Programs continued to proliferate, and basic problems dating back five or more years remained unsolved.

In the free enterprise system, where it would appear that a unique value to the marine technician would give him a competitive advantage in the market place, no such patterns have clearly emerged. However, there is confidence that the numerous problems can be surmounted if properly understood. Therefore, it is the purpose of this study to reassess these programs in order to provide the Office of Sea Grant with guidelines for future program management decisions.

Three areas of investigation and action were pursued in order to assess the current state of marine technician training and employment.

(1) *research into the nature and development of emerging training programs and supply/demand relationship for technician occupations in the marine sciences*

Although aware of recurring problems encountered by other researchers -- e.g., the lack of standard definitions and job classifications, and disappointing returns of survey questionnaires--the fundamental data collection tool continues to be the survey.

Three questionnaires were designed and distributed: A student questionnaire, an educational institution questionnaire, and a questionnaire for employers.

Table S-1 provides a summary of the questionnaires sent and returned.

Table S-1. Assessment Study Questionnaire: Rate of Return

questionnaire	sent (number)	returned (number)	returned (percent)
Students	475(95x5)	65	14
Educational Institutions	95	41	43
Employers			
--private industry	1,452	296	20
--government agencies	110	50	45
--educational institutions	105	49	46

An analysis of the results appears in a later section.

(2) *site visits with directors and staff of marine technician training programs and with employers of their graduates*

Particular attention was devoted to the following points during the site visits:

--student placement

--institutional-employer involvement

--curriculum

--facilities and equipment

--faculty

--program administration

(3) *workshops to allow and observe interaction between professionals closely associated with marine technician training*

Part of the study input came from two workshops that had been designed to give the marine technician training community the same sort of opportunity to exchange views and concerns as had earlier conferences. The discussion items listed below were the same for the two workshops.

- Student Placement
- Degree of Specialization
- Length of Program
- On-the-Job Training
- Student Retention
- Faculty
- Surveys
- Program Costs
- Evaluation
- Recommendations

--in general workshop participants felt that the job market for their students was soft.

On-the-job training has been added to a number of curriculums and is far more evident than in 1970. It was pointed out however that OJT programs could be and have been blocked by unions.

An overall recommendation that emerged from the workshops which was given strong expression states that:

An organization is needed to certify marine technician graduates and to promote the concerns of students and administrators. This organization would also help training institutions convince employers in all sectors of the value of the formally trained marine technician as an employee.

Supply and Demand

As stated earlier in this document, the problem of acquiring information with which to analyze supply and demand continues unsolved. Industry as a source of information has been extremely difficult to analyze because the fraction contacted is so uncertain.

The broad dimensions of the Supply-Demand problem are captured by the magnitude of discrepancy found in this survey between the number of marine technicians recently trained and the number of jobs available to them as program graduates. If the data are to be believed, demand will double in 34 years while supply will double in about 5.

In addition, students of many nonmarine programs could fill the jobs reported by industry,

particularly since

employers answering the questionnaires reflected an uncertain understanding of the nature of trained marine technicians.

The net effect of all the factors developed as a result of the survey is that schools may be preparing students for jobs that employers do not recognize, a point that has been elaborated in several studies on the marine training community.

Despite the fact that the job market for marine technicians has been considered soft at least since 1970, enrollments in training programs increased sharply from 1972 to 1973, and will probably continue to increase in 1974 to 1975.

The more than 300 percent average rise in enrollments from 1970 to 1975 would seem to indicate several possibilities: (1) That despite pessimism voiced at the 1973 workshops and on other occasions, program directors are optimistic about the job market; (2) A reluctance to manage program reductions after the hard sell that initiated them; or (3) The local picture of employment opportunities is quite different from that for the nation and region - the latter two being more pessimistic. The last is clearly not the case.

Responses of students, educational institutions, and employers when asked their opinions of the current job market reflect more optimism on the part of educators than on the part of other groups. Where the question applies to the local market, however, the optimism is considerably tempered, the local perception of remote markets being more favorable. Because of the role played by advisory councils and surveys of local needs, it is fair to assume that educators are more familiar with the local market than with the statewide and national markets. One-of-a-kind programs are not adversely affected, whereas common programs compete for opportunities that are always in someone else's backyard. The student is squeezed between pessimistic employers and optimistic educators.

The weakest link in assessing the status of the marine technician is the demand side of the employment picture.

> *The overall questionnaire response from the private industry sector was too low (20%) and by and large incomplete. It is felt that much of the demand for marine technicians still emanates from the private sector as evidenced in an earlier study which indicated that 75% of all technicians are employed by industry.*

Problems whose answers remain key to adequately assessing the status of MTT are:

- *The inability to identify industries which employ technicians through any simple criterion such as Standard Industrial Classification (SIC).*

Conceptually, the reason for the emphasis upon SIC coding is to develop a basis for projecting demand through associated sales, payroll, value added, or other similar statistics descriptive of business activity.

- *The lack of uniformity of the definition for a technician.*

The second complicating factor affecting demand is the inadequate definition of the term marine technician. The variability of technical competence implied by the diverse descriptions of a technician is very great, and complicated by the associated problem of defining occupation clusters. Occupation clusters should be marine dependent rather than only marine associated.

- *The lack of visibility into the attitude of employers toward the role of the technician, and relative value of the graduate of a 4-year program vis-à-vis the graduate of a 2-year program.*

- *The inability to quantify the comparative preference of industry for CJT vs. academic training, and*

- *The structure of marine industry itself which because of the size (either very small or very large) participation makes it difficult to isolate and acquire relevant data. Many of the small companies are privately held, therefore information concerning operations is not usually published. The large diversified companies do not distinguish their marine activity in overall corporate reports.*

The conclusions reached in other studies with similarly insufficient information, particularly those conducted by personnel with a vested interest in the outcome, suggest that it may be difficult to maintain objectivity when faced with the opportunity to create new programs.

Recommendations

Although the information available can hardly be considered adequate for rigorous quantitative analysis, the trends evidenced in recent literature as well as in the limited results of the current questionnaire, lead to the following recommendations:

Recommendation 1

The Interagency Committee on Marine Science and Engineering should encourage the appropriate agency to establish an office in which the following activities would be developed and maintained:

a. a national source of manpower data relating to supply and demand of marine technicians regionally and nationally, the data to be compiled and disseminated on an annual basis;

b. interagency coordination of marine technician training program sponsorship;

c. objective yet flexible criteria for decision-making regarding initial or continuing funding of marine technician training programs;

d. assistance to existing training programs in reaching a realistic assessment of their activities;

e. the means for dynamic involvement of students, educational institutions, and employers in order that the interests of all in the marine technology arena be understood and pursued in an atmosphere of mutual understanding of goals.

The collection of adequate data is so vital to the assessment of supply and demand, federal sponsorship of educational programs should be made conditional to the maintenance of adequate records.

INVEST IN IMPROVEMENT OF THE DATA BASE

Recommendation 2

Until such time as adequate manpower data are available, and until the success of existing programs can be evaluated, the Interagency Committee on Marine Science and Engineering should recommend to Sea Grant and other sponsoring agencies that:

a. requests for federal funds for existing marine technician training programs be more carefully scrutinized and evaluated by sponsoring agencies;

b. requests for federal funds for the establishment of new programs be denied, except where clearly documented manpower needs, particularly local, verified by the sponsoring agency, can be provided along with documentation showing that existing programs can not meet these needs;

c. all programs receiving federal sponsorship be held more closely accountable for providing detailed employment records of program graduates.

Pursue a program development strategy which minimizes risk to the student. In the absence of better information from the user, a shortage of trained personnel is preferred to an overabundance.

LET SUPPLY LAG DEMAND

Encourage only selective types of marine technician training programs because

a. Accumulated data, however incomplete, shows that supply is increasing at a much faster rate than demand.

b. Respondents were universally unenthusiastic about future opportunities.

Recommendation 3

Initiate action with prospective users, particularly industry, to create a more credible picture of demand. Since a major purpose of MTT programs

is to fill a declared need of the user, than the users, in good faith, should be willing to provide the data needs. No data--no programs!

As part of this effort, develop definitions with the help of employers for

- Marine technicians
- Marine occupations
- Marine occupation clusters

Recommendation 4

In order to alleviate placement problems of students recently trained or currently in training, and while awaiting the implementation of the above recommendations, the Interagency Committee on Marine Science and Engineering should immediately initiate a special effort to:

a. identify marine-technician level jobs within the federal establishment;

b. disseminate this information to marine technician training program directors.

Part I

THE ASSESSMENT STUDY

The Nature of the Study

The purpose of this study is to reassess the status of marine technician training programs in order to provide the Office of Sea Grant with guidelines for future program management decisions. After 5 years of undirected activity and discussion, the following question remains to be answered: "Where does the country stand today with respect to training and employment of marine technicians?"

The study was initiated in September, 1972 at the request of Dr. Robert White, Administrator, NOAA, and Chairman of the Interagency Committee on Marine Studies and Engineering (ICMSE). Study findings along with resultant recommendations, were to be presented to the Committee's Chairman in November, 1973.

The fundamental data collection tool is the survey - mail, interview, telephone - and with the use of this tool there are the related fundamental problems of participant selection (the sample) and participation.

The results of the first year of study indicated that additional effort should be expended to examine the industrial sector as an employer. This phase of study was completed in April, 1974.

Study Methods

Three areas of investigation were pursued in order to assess the current state of marine technician training and employment.

--research into the nature and development of emerging training programs and occupations in the marine sciences

--visits with directors and staffs of marine technician training programs and with employers of their graduates

--workshops to interact with professionals closely associated with marine technician training

Each is briefly discussed below.

Research

Marine Technician Training (MTT) has received extensive and continuing attention during the past 10 years resulting in a number of publications considered landmarks by the marine technician training community; Chan (Ref. 6), Daubin and Mavor (Ref. 10), Rechnitzer (Ref. 19), Gillie and Pratt (Ref. 11), and Heinkel (Ref. 13) to name a few. These and other contributions to the literature were carefully reviewed in the light of recent history: hypotheses and assumptions were reexamined, and investigations initiated where needed to gain new information, establish trends, develop methodology, and define guidelines for MTT program management. Since these historical reports are familiar to those concerned with the field, a review of the literature will not be presented here.

Notwithstanding recurring problems encountered by other researchers -- e.g. the lack of standard definitions and job classifications,

and disappointing returns of survey questionnaires--the fundamental data collection tool continues to be the survey. Hence, in the course of this study, questionnaires were mailed to marine technician students, educators, and employers, and some followed up by visit or phone. In other cases, telephone calls were the only contact.

Recognizing the shortcomings of the data collection methods, at best the survey could result in current data of benefit to the study and to the respondents. At worst, weaknesses in communication, already well documented by earlier efforts, would be reinforced. Three questionnaires were designed and distributed: A student questionnaire, an educational institutional questionnaire, and a questionnaire for employers. An overview of the results will be found in Part III of this report.

The employer data collection program was conducted in two stages. First, a general survey of industrial, governmental agencies, and educational institution employers. This was followed after analysis of the responses, by a spot survey of representatives of industry segments particularly significant to MT employment because of local employment histories, economic growth, or continuing historical employment trends over the decade of investigations.

More detailed discussion of the research methods will be provided in each section of this report where appropriate.

Visits

Institutions offering marine technician training programs that were visited during the course of this study are listed in Appendix II, with brief descriptions of their academic programs.

Particular attention was devoted to the following points during the site visits:

--*student placement*

--*institutional-employer involvement*

--*curriculum*

--*facilities and equipment*

--*faculty*

--*program administration*

Workshops

Two workshops held in 1973 as part of the assessment study are described and discussed in Part II. Lists of attendees are included in Appendix I.

Additional Activities

A significant result of the above activities was the beginning of informal dialogue with program directors and instructors, and with potential or actual employers of marine technicians, which facilitated a continuing exchange of views on employment levels and rates. As noted earlier, in many cases, further visits, telephone conversations, and correspondence followed the initiate contact made by questionnaires or site visits in an effort to clarify information and better understand the respondents' perspective of the questions that were being asked. Followup of private industry was considered of special interest. Visits were made to a number of employers, some of whom had answered the questionnaires, and some of whom had not. Impressions gained in the field,

while not quantifiable because they were so sparse and incomplete added a dimension of understanding that could not be gained from the impersonal nature of questionnaires alone.

Part II

BRIEF HISTORY OF MARINE TECHNICIAN TRAINING PROGRAMS

Introduction

The history of marine technician training programs in the United States parallels to a great extent the history of national concern with imaginative and beneficial utilization of the nation's marine environment. Both are relatively recent phenomena.

Although events that occurred prior to 1968 will be available too, the history of marine technician training programs is basically confined to the past five years, as illustrated by Table 1. In reading this Table, note that a number of institutions offer more than one program in marine technology. Therefore, the number of programs exceeds the number of institutions.

Table 1. Number of Institutions Offering Marine Technician Training Programs, 1965-1973

year	New Starts	cum.number
pre-1965	1	1
1968	8	9
1970	12	21
1973	13	34

At least four significant events seem to have spurred this proliferation of programs:

--*1966; establishment of the National Sea Grant program*

--*1968; first AACJC conference on marine technician training, and publication of the Chan monograph*

--*1969; publication of the Stratton Commission Report*

--*1970; second AACJC conference on marine technician training*

A number of more recent events of significance also reported were major discussion points featured at the Marine Technician Training Program Directors Workshops convened as part of this assessment study. The results of these discussions will conclude this brief history.

The Role of the National Sea Grant Program

Background

In a speech entitled "Education in Marine Science and Technology," presented to the American Association for the Advancement of Science, Dr. Robert B. Abel (1967) noted that the history of education in oceanography was "as complicated as the interdisciplinary nature of the field itself." With regard to developments beginning in the 1950s, when the National Academy of Sciences and the Congress first became aware of the educational problems involved in the expansion of marine science endeavors, Dr. Abel listed several steps taken in that decade:

a. Congress formed a subcommittee on oceanography.

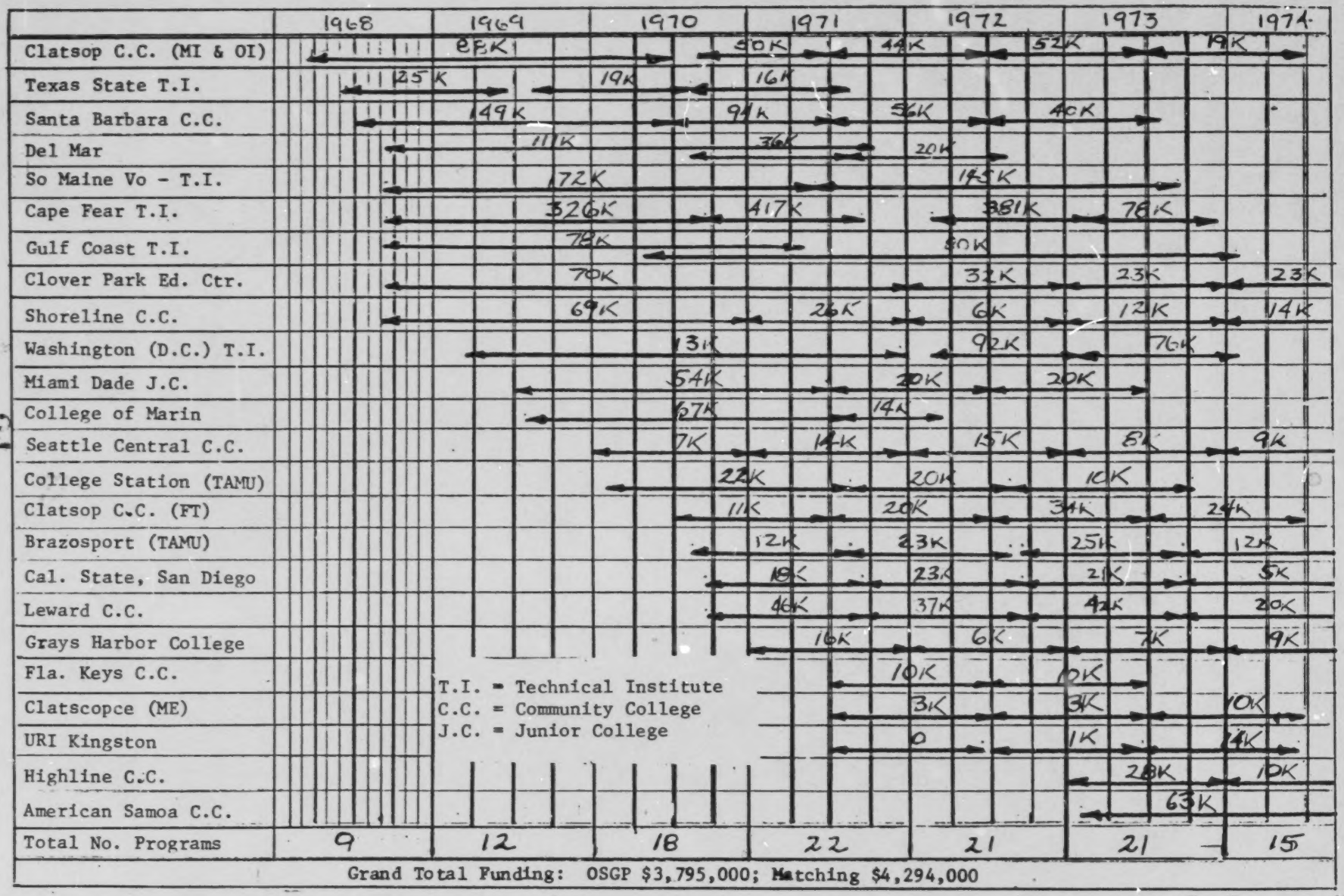
b. More than twenty federal agencies joining in common cause established the Interagency Committee on Oceanography with special panels on research and education.

c. The federal budget for oceanography rose approximately 20 to 30 percent for about four years, highlighting research and education.

d. One university after another discovered that people who had hitherto been minding their own business in departments of biology, geology, etc., had really been oceanographers all the time. *"Curricula in oceanography were glued together as fast as the deans could spell ONR."*

By 1960, several oceanographic education centers could be found in the United States. Continued interest and development in the marine sciences led to the establishment of the National Sea Grant Program in 1966. The program was closely tied to educational institutions, again underlining the national interest in producing graduates who would advance and enhance burgeoning marine activities.

The increased output of highly educational oceanographers produced another demand. To carry national marine research and development forward at an acceptable rate, support personnel able to assume day-to-day mechanical and technical tasks were needed. Strong interest in developing educational programs for marine technicians became apparent in 1968; since that year, a number of junior colleges, with the support of Sea Grant funds, have entered this relatively new training field (see Chart, opposite page).



Grand Total Funding: OSGP $3,795,000; Matching $4,294,000

Office of Sea Grant Support of MIT Programs ($ Rounded to 000s)

Program Support: Sea Grant and Other Federal Agencies

The National Sea Grant College and Program Act of 1966 was fundamental to the accelerated training of marine technicians; one of Sea Grant's objectives was to provide funds for technician training, which at that time had not been undertaken by universities and colleges involved in marine sciences. Ninety percent of the marine technician training programs (80% of the institutions) in 1970 had at one time or another received Sea Grant funds. Those that received Sea Grant funds for technician training for the academic year 1973-1974 are listed in Appendix II.

New training programs received aid from other federal agencies as well as from the Office of Sea Grant. Certain vocational-technical education block grants to states issued through state Offices of Education were used to support local marine technician training programs. At least one program (for American Indians) was sponsored by the Office of Economic Opportunity. The Department of Labor funded a short-lived District of Columbia program for low-income minority youths, as well as a joint program in Texas involving an electronics firm and a technical institute, also short-lived. The Environmental Protection Agency also supports a number of junior colleges in training for technical personnel in the field of water quality.

In the speech cited earlier, Dr. Abel called the entry of other federal agencies into the marine technician training field unfortunate, in that it gave rise to "a fear that the supply of ocean technicians will shortly exceed demand and we will be turning out people without jobs." This phenomenon serves to illustrate the still prevalent problem

of differences between (1) state and national perceptions of need, and (2) perceptions of state and national needs. This will be discussed further in the analysis of demand.

Abel went on to say that since "this very unhappy situation" was beyond the control of Sea Grant, that agency would accordingly reduce its program sponsorship, despite its conviction that it was the best qualified sponsor in the field. But as the Chart (p. 13) indicates, this was easier said than done. It has taken 4 academic years to wind down the number of programs, including a number of new starts.

The Sea Grant Program's most recent expression of interest with respect to Marine Technician Training is contained in the following statement of objectives derived from a recent Sea Grant long-range plan:

> --To bring to self-sustained maturity the oceanographic aide and marine biology aide technician programs initiated successfully under Sea Grant. (No more will be added in the foreseeable future).
>
> --To bring to self-sustained maturity existing fishery technician courses and to add new courses in support of specific regions and fisheries as industry may require.
>
> --To add marine options and elements to improve the level of competence in seafood processing, in established food science and technology technician courses, in geographic areas where industry is in need of better trained people.
>
> --To add marine options and special courses in marine engines, hydraulics, and refrigeration in established technical vocational courses as local need may require.

The Stratton Report

In 1967, the Commission on Marine Science, Engineering and Resources chaired by Dr. Julius A. Stratton, began its investigation of

all aspects of marine science in order to make recommendations for an overall plan for an adequate national oceanographic program. The ensuing report (Ref. 17) provided another spur to the development of marine technician training programs by recommending that additional training programs be created.

The Commission's Panel on Education, Manpower, and Training found that "Reliable data were inadequate or non-existent for many aspects of its task; that programs, particularly at the Federal level, were poorly coordinated; and that the history of marine sciences over the past decade has been characterized by an empahsis on basic and applied research at the expense of education and training." It further stated that "The manpower situation in the marine fields is not critical, although shortages do exist in certain areas, and that it is impossible to predict future supply/demand conditions with any precision" (emphasis added).

The Commission perceived the need for a better system for the collection, analysis, and dissemination of information relating to training programs and their needs, to be urgent. Therefore the Panel recommended that a Marine Statistics Center be established within one government agency. It was hoped that this agency would be the Office of Marine Education, Training and Manpower, whose creation was to stem from another recommendation of the Commission.

No action was taken on these recommendations, but a change in organizational structure did take place: the Office of Sea Grant, established within the National Science Foundation, was transferred to the newly-created National Oceanic and Atmospheric Administration (NOAA).

In an attempt to foresee the manpower demands expected to result from Stratton Commission recommendations for oceanographic research and development, Sea Grant was clearly charged with stimulating the development of marine technician training programs.

The Role of the American Association of Community and Junior Colleges

1968 Conference

In March, 1968, the American Association of Community and Junior Colleges (AACJC), in cooperation with the National Sea Grant Program, sponsored a conference in Florida to "Investigate the capabilities of the two-year community and junior colleges to promote marine resource development by training marine technicians" (Ref. 11).

Later that year, the Association published the results of Gordon L. Chan's California survey (Ref. 6). The report appears to have been accepted by members of the AACJC as proof of a sharply rising demand for formally trained marine technicians. There is no doubt that it strongly influenced the entry of two-year colleges into the field, even though, along with his data, Chan had included a rigorous checklist for schools considering the establishment of such programs. Speaking in 1973, Richard C. Benson (Ref. 2) traced the creation of about 20 programs to the 1968 AACJC conference and subsequent publication of Chan's survey.

Chan felt that the required 415 new technicians with four-year training could be supplied by existing programs in California; the 88 percent of technicians needed within the five years following his study would come from junior college programs.

Since 1968, questions have been raised concerning the estimates on which Chan based his report. Gordon (Ref. 12) for example, wrote that:

> Chan estimated that California would need about 415 new marine technical employees with bachelor's degrees between the years 1968-1973. He estimated that about 43,000 "technicians" were employed in marine-science occupations throughout the United States in 1968. His figures appear to be high, although his statistics were reported at the 95 percent confidence level. If his figures were reduced to half, a large employment potential would still exist.

Speaking of the California survey, Rechnitzer (Ref. 19) noted that "less than six months after its publication Mr. Chan found it necessary to revise his estimates of needs downward by a factor of approximately 4.5, a decrease in foreseeable demand of 78 percent." Another writer stated: "I have reason to believe the survey data gave a false impression of the real manpower needs for oceanographic technicians and may have unduly stimulated interest in developing additional training programs, at least in California" (Ref. 3).

It is important to try to gain some insight into possible reasons for trouble with the Chan forecast particularly if the same data collection tools are to be used.

In retrospect, it appears that greater caution might have been exercised in the use of proportional forecasting, a method strongly dependent on comparability of characteristics between different areas. It is particularly relevant to the marine technician problem because so few respondents in the sample (10% of the organizations) contributed so heavily to the employment of technicians (70% of the technicians). In this particular case, proportional forecasting implies the existence

of similar industrial distribution situations nationally, a phenomenon not established by the study. Also the most prevalent disciplinary type is the large group, electronics technicians, whose marine role was not established. In short, sample segmentation is required to gain a better understanding of causality.

1970 Conference

Following the events of 1968, the Office of Sea Grant called for a general assessment of marine technician training programs. To begin the assessment, the Office cooperated in sponsoring a second AACJC conference. Representatives of 20 training programs, along with experts (a total of 5) from industry, government, and marine education were invited to attend this August, 1970 conference.

The conference report, (Ref. 11) reflected the growing concerns of the marine technician training community at that time. The three main concerns appeared to be:

1. *how to judge the job market in light of student placement needs;*
2. *how to determine optimal program length and appropriate courses; and*
3. *how to recruit and retain students*

While some of the concern with the situation was attributed to the general tightness of the job market in 1970, "several conferees from two-year colleges and the marine industries implied that earlier predictions of need for certain kinds of marine technicians were either inaccurate or were misread by program planners." The hundreds of jobs recently predicted for one location were not available, nor would they be in the near future. It was recommended that local and

regional surveys be undertaken as the first step in determining if a specific program should be initiated, a suggestion also made by Chan in 1968. The 1970 report included a complete survey strategy.

Although the program dealt at some length with Institution-Employer involvement, the meager participation by the community of employers is symptomatic of a communications gap that continues to affect the development of a national Marine Technician Training program.

The 1973 Workshops

Concerns identified in 1970, particularly the concern about student placement, continued to be the topic of reports and discussions in 1971 and 1972.

By 1971 it had become apparent to many that earlier predictions of a sudden boom in the marine sciences were overoptimistic. Marine technology program directors began voicing their concern with employment potential for their graduates. Some took immediate steps and placed quotas on enrollments; others took no action.

Some continued planning new programs and additions to existing ones.

By the beginning of 1972, the Office of Sea Grant had begun to receive reports of trained marine technicians who could not find jobs commensurate with their educational background. These reports were accompanied by requests for assistance, often in the form of questions: Are existing data on manpower needs and trends in the marine sciences reliable? What type of marine technician training curriculum will be of greatest service to the student in his or her future employment? The

list of questions grew. Industry wanted to know just what a "marine technician" was. Students simply wanted to know where they could find a good job.

By mid-1972, the lack of employment opportunities appeared to warrant serious attention. The Interagency Committee on Marine Science and Engineering (ICMSE) requested that the Sea Grant Program initiate a study of the situation.

Part of the study input was to come from two workshops designed to give the marine technician training community the same sort of opportunity to exchange views and concerns as had the 1968 and 1970 conferences. But again without the benefit of substantive input by employers.

The East Coast Marine Technician Training Program Directors Workshop was held in May, 1973; it was followed by a West Coast workshop in June. Discussion items listed below were the same for the two workshops.

- Student Placement
- Degree of Specialization
- Length of Program
- On-the-Job Training
- Student Retention
- Faculty
- Surveys
- Program Costs
- Evaluation
- Recommendations

Salient concerns and reactions are discussed in the following sections.

1. Student Placement

Directors of some programs reported 100 percent placement of their graduated classes; but in general, workshop participants felt that the job market for their students was soft. The amount of federal or state funds allocated to marine science affects their students directly; when budgets for marine fields are decreased or not increased, the marine technician's career can suffer.

Any optimism expressed was tied to increasing national interest in ecology and the environment. Program directors felt that their students and graduates could constitute a vanguard of skilled workers in environmental control. Many directors were concerned however about competition for jobs between marine technicians and water quality technicians trained partly with EPA grants. National concern with locating new sources of energy was also thought to be of possible benefit to the technician market (because of potential OCS activity).

2. Degree of Specialization

Workshop participants reached no consensus concerning the degree of specialization desirable in training programs, an aspect of training that has been the subject of attention at least since 1970. However, one participant, Captain Arthur W. Jordan, felt that the reason for a lack of jobs may be that programs are too academically oriented, thus not providing students with sufficient technical skills. (Captain Jordan subsequently read a paper on this subject at the Ninth Annual Marine Technology Society Conference, Spetember, 1973). This appears to be borne out by notations on questionnaires and letters of transmittal which bemoan a lack of hands-on competence for the graduates of some technician programs.

3. Length of Program

A number of program directors questioned whether two years was sufficient time to give students the grounding they need to fill demanding jobs. They suggested that perhaps it requires more than two years to develop a scientific and vocational appreciation of the marine environment. Some programs offer summer extensions in an attempt to intensify training.

Updating and upgrading of programs can also affect program length. This effect was evident in fisheries curriculums, when new gear and techniques were incorporated into programs. More field time also was being offered to fisheries students.

General marine technology curriculums showed less updating. Schools with strong advisory committees and with sufficient funds for new equipment seem to keep pace with new developments better than those lacking these advantages. As in other areas, the financing of a program determines to a great extent the amount of attention program directors are able to devote to updating of curriculum, course content, and equipment.

Degree of specialization and program length appear to create conflicting arguments in the community of educators. Some wish to broaden, others to narrow, training. A review of placement records provided by some of the more specialized programs indicated that as recently as the Class of '73 highly specialized vocationally oriented programs were successful in experiencing high employment rates (Highline CC, Santa Barbara CC, Miss. State Univ.).

4. On-the-Job Training

On-the-job training (OJT) has been added to a number of curriculums, and is far more evident than it was three years ago. As the majority of representatives at the workshops reported little demand for their graduates and felt that competition for existing jobs was keen, employers were seen to have their pick of applicants. BA and even in some cases MA graduates were known to have accepted jobs that could be filled by 2-year graduates. Program planners hoped that OJT programs would enable their

students to find jobs commensurate with their training, and perhaps even give them an advantage when competing with graduates of four-year institutions. It was pointed out however that OJT programs could be and have been blocked by unions, particularly in the field of diving. Certainly the establishment of certain types of OJT programs is not without problems.

5. Student Retention

Workshop participants expressed satisfaction with the decreasing student dropout rate, which has diminished each year. They felt that screening of applicants had become more efficient, and that more attention was being given to reading and writing skills of entering students. Some participants complained however that high schools were not giving adequate grounding in basic reading, writing, and mathematics skills.

6. Faculty

Program directors expressed general satisfaction with the caliber of their schools' instructors. Recruiting faculty, whether those with academic degrees, those with experience working in the marine field, or those with both qualifications, seemed to present no real problems. Salaries appear to be on a par with salaries of instructors in other vocational fields, though often less than salaries of skilled, experienced marine workers.

7. Surveys

Even though the need for surveys of local and regional manpower requirements has been stressed in a number of reports, workshop participants found such surveys of little value. They relied primarily on their

advisory committees for job market guidance. They considered it of the greatest importance to select members of the committees carefully; members should be truly cognizant of employment opportunities in marine areas.

National surveys compiled on the regional level would nevertheless be of greatest assistance to attendees, who mentioned the Office of Sea Grant and the Department of Labor as two possible future sources of such surveys. They felt that these surveys would have to be conducted regularly, to be of value and that the distribution network would have to include all relevant sponsoring agencies and schools.

Perhaps the reason for interest in regional rather than local surveys is that job potential on a regional basis seems to exceed local employment potential. Survey tools focused on a region would reveal a more viable market for which to prepare students. On this basis however, one might be forced to question the credibility of market estimates based on the possibilities for multiple counting of the same demand. In addition, lack of time, money, and manpower render it difficult for individual schools to run acceptable local surveys.

8. Program Costs

Many program directors were unable to speak of program costs in specific terms. A report on vocational-technical education costs issued by the state of Washington was said to conclude that vocational training costs three times as much as education in the liberal arts. Marine technology programs entail costs beyond those of many vocational-technical programs.

Workshop participants were concerned with discovering what makes a cost-effective program, and wanted guidelines that would help them

determine cost effectiveness. They felt that this information would put them in a stronger position when requesting funding.

9. Evaluation

Program evaluation was conceived of mostly in terms of followup of graduates and review of advisory council input, as typified by Heinkel & Tependino (Ref. 13). In the case of the followup however, learning if and where a student is employed usually does not extend to questions concerning the nature of the employment, nor the appropriateness of training for end use. There is little evidence that evaluations are conducted comparing level and type of training with job requirements. Is it necessary, for example, that an oiler/wiper be a graduate of a 2-year training program?

While most program directors indicated that they would like more evaluative information, they also indicated that they lacked the resources to search out and assemble the necessary data. The program directors already carry heavy loads in teaching as well as administration, and their budgets do not allow for hiring an evaluation specialist.

10. Recommendations

An overall recommendation that emerged from the workshops which was given strong expression states that:

> *An organization is needed to certify marine technician graduates and to promote the concerns of students and administrators. This organization would also help training institutions convince employers in all sectors of the value of the formally trained marine technician as an employee.*

Discussions concerning the selection of an appropriate organization were inconclusive. The established scientific organizations were seen

as aloof from the concerns of vocational-technician educators. A prime candidate would seem to be the AACJC; there are some feeling, however, that the Association had not followed through in investigating means of aiding program directors after the 1970 conference; an alternative might be patterned after professional societies, i.e. an Association of Certified Marine Technicians.

As a result of the inaction after the 1970 conference, the concerns voiced openly at that time have been intensified rather than resolved.

Conclusion

Spurred by the rhetoric of what appeared to be a concerted national effort to develop marine resources and by the interest of two-year institutions in offering students training for technician careers, the number of schools offering marine technician training has catapulted from 1 to 34 since 1965.

Early in this brief period of continuing expansion, questions concerning the viability of continued expansion were raised. Program planners searching for reliable manpower data from which to forecast future needs came up empty-handed. Accurate surveys prepared on a national scale were not available. Surveys compiled polling local employers too often revealed a lack of "product" understanding on the part of industry. Funding and advice were made available from various government agencies, but due to compartmentalization of interests, no single federal agency could be relied upon to provide an overall picture of the marine technician training community.

In 1973, little seemed to have changed. Programs continued to proliferate; and basic problems dating back five or more years remain unsolved. In the free enterprise system, a unique value ascribable to the marine technician would give him a competitive advantage in the market place; but no such patterns have clearly emerged. It would seem timely to determine whether:

(a) the attributes of the jobs are such that they don't require unique training

(b) the schools are not concentrating on those opportunities which benefit most from uniquenesses of the environment

There are still no surveys, no focus of responsibility, no evaluation programs and no reliable data base.

Part III

OVERVIEW OF SURVEY DATA

Introduction

Five student questionnaires were sent to each of 95 schools, for a total of 460 questionnaires. Sixty-five (14 percent), representing 15 schools, were returned.

Ninety-five questionnaires were directed to educational institutions selected from Environmental Education in the Community Colleges by Arden L. Pratt, Marine Technology Programs by Angelo C. Gillie and Arden L. Pratt, and University Curricula in the Marine Sciences and Related Fields published by the Interagency Committee on Marine Science and Engineering. Questionnaires were returned by 41 (43 percent) of these institutions, representing 18 states, the District of Columbia, and Puerto Rico.

The employer questionnaire was sent to private industries, government agencies, and educational institutions. Industries were selected from Under Sea Technology Handbook Directory 1971-72 (Ref. 24) Section B. Of 1,452 companies selected, 296 (20 percent), representing 35 states and the District of Columbia, returned questionnaires. Eleven percent were returned unopened due to incorrect addresses. One hundred ten agencies listed in Section G of the same publication were polled; 50 (45 percent) responded. Educational institutions known to employ personnel

in marine sciences also received the questionnaire, supplemented by a list of Sea Grant Program Directors. One hundred five questionnaires were sent, and 49 (46 percent), representing 20 states were returned.

Table 2 provides a summary of the questionnaires sent and returned.

Table 2. Assessment Study Questionnaire: Rate of Return

Questionnaire	Sent (number)	Returned (number)	Returned (percent)
Students	475	65	14
Educational Institutions	95	41	43
Employers			
--private industry	1,452	296	20
--government agencies	110	50	45
--educational institutions	105	49	46

These figures can be put in perspective by comparing them with data from other surveys listed in Table 3. Note however that the latter involved limited geographic areas, which may have been somewhat easier to solicit for returns than was the national scene surveyed by this assessment study.

Similar tabulations for questionnaires issued by Rechnitzer (Ref. 19) to students, educational institutions, and industry and government employers in California and elsewhere were not provided in his report. Rechnitzer does however make a statement regarding the results of his survey that might well be applied to the results of the present surveys:

Table 3. Other Marine Technician Training Surveys: Rate of Return

survey	sent (number)	returned (number)	returned (percent)
Chan: The California Report on the Education and Training of Marine Technicians, 1968.			
employers (industry, agencies, educational institutions)	484	152	31
Daubin and Mavor: Final Report of the Massachusetts Marine Science and Education Study, 1969.			
students	150	54	36
educational institutions	115	82	71
employers (industry, agencies)	68	30	44
Gordon: The Education, Training, and Classification of Marine Technical Personnel (Seagoing), 1971. (Florida)			
employers (industry)	79	41	52
Heinkel: An Assessment of the Marine Industry and Marine Technology Programs in Community Colleges in San Diego County, 1972.			
students: current	39	n.a.	
former	31	16	52
employers (industry)	110	104	95

> *Although they did not produce numerical data that merit statistical manipulation and interpretation, the returns have significant subjective value.*

Rechnitzer also felt that the quantitative data of past manpower surveys related to the marine sciences are only of subjective value. He gives as reasons the lack of precise common definitions of job classifications (a problem especially evident in the employer questionnaires returned by industries, agencies, and educational institutions polled by this study), and varying conceptions of what constitutes the activities and functions of the field of marine sciences.

With the qualifications of these past surveys in mind, the following overview of the results of this assessment study is presented starting with student responses, followed by educators, and closing with the responses of employers. Other parts of this report depend to a considerable extent on these results.

STUDENT QUESTIONNAIRE

SECTION I

GENERAL INFORMATION (Optional)

1. Name: Sent 460; 65 Responses (14%)

2. Age: Average 25; Range 18-47

3. Sex: 90% Male

4. State in which you are a legal resident 15 states and D.C. represented Cal. 25%, Fla. 9%, N.C. 9%

5. Name of Educational Institution 15 Institutions Represented

6. Student Classification (Circle one) Major % circled.

Semester	Quarter	Trimester
36%	12% 16%	
1 2 3 (4)	1 (2) 3 4 5 6 (7) 8	1 2 3 4 5 6

7. Are you a full-time 95% or part-time 5% student? Check one

SECTION II

EDUCATIONAL HISTORY

1. Do you have (1) high school degree, or (2) a certificate of completion (Please indicate below)

   1. 86% 2. _____

   None _____ Other GED - 9%

   a. In what area was the majority of your high school program based (Please check one)

College Preparatory	62% *
General Studies	22%
Vocational-technical	12%
Other	4%

Very large proportion College bound.

2. Which of the following tests have you taken? 41% more than one

College Entrance Examination Board (CEEB)	36%
American College Testing Program (ACT)	33%
College Qualifying Test (CQT)	
American Council on Education (ACE)	
General Abilities Test Battery (GATB)	25%
None of the above	17%
Other:	

Commentary are CEEB and ACT required for 2 year program entry.

3. From whom did you get the guidance, advice or inspiration that helped you decide to pursue an education in Marine Technology?

High School Counselor	0
High School Instructor	
Person in marine field	22%
Parent	
No one	41%
Other:	

Either very independent or neglected.

4. While in your last year or two of high school, was it your intention to pursue training in the field of marine technology?

Yes 23% No 76%

a. What might have been the most influencing factor in your decision to pursue training in marine technology? (Please check one)

Personal counseling from others _____

Personal attraction to the marine field 80%

Media influence; i.e., TV, newspapers, etc. _____

Other _____

b. Was marine technology your first choice as a major in college?

Yes 50% No 50%

c. If not, what was your first choice as a major? Describe:

Electronics, History, Political Science, Biology (18 fields)

5. Who assisted you in planning your present program?

College Counselor	20%
College Instructor	34%
Person in Marine Field	
Parents	
No One	31%
Other:	

Very large proportion unadvised; indictive of high degree of independence or poor counseling.

SECTION III

CURRENT EDUCATIONAL INFORMATION

1. Indicate the type of marine technology program in which you are currently enrolled (Please check one).

General marine	(14)
General oceanographic	(14)
Fisheries	(7)
Underseas (diving)	(14)
Ocean engineering	
Marine propulsion	(1)
Marine electronics	(8)
Commercial fisheries	(1)
Marine engineering	(2)
Marine survey	(1)
Other	(10)

a. Within the program selected above, do you have a major, or are you concentrating in any one aspect of your program?

Yes 41% No 59%

b. If so, in what area? Describe: 17 major fields listed *(15 programs with 17 major fields of concentration implies excessive flexibility or misunderstanding).*

2. While attending school are you employed in a field that is within or relates to your marine technology program?

Yes 25% No 75%

3. Are you active in any campus extracurricular activities, i.e., sports, politics, community, social action, etc.?

Yes 42% No 58%

4. What percentage of your overall course work is devoted to subjects outside of those that directly relate to marine technology; i.e. English, social science, literature, etc.? Please indicate by percentage).

Avg 27%
Modal Value 20%
Range 0-90%

within one program responses ranged from 30-90%.

5. Have you been, are you currently or will you be involved in any field activity program that is sponsored and designed by the marine technology program at your campus which is aimed at providing you with a first hand experience in practical applications of marine technology?

Yes 95% No 5%

6. Assuming that the average length of time required to complete your current program is two years, what do you estimate as the total cost of your education? (Please consider all costs related to your education; i.e., tuition, room & board, transportation, laundary, etc.).

Avg $4550
Modal $2550
Range $0-12,000
Median $3,500

a. Do you live with your family or on your own? (Please indicate below).

18% with family - 82% on own

b. Who is paying for your education?

	S	M
Parents	(20)	15%
Self	(69)	59%
Other	(11)	26%

c. From what sources are your educational expenses being paid? (Please check appropriate item).

	S	M	
Savings	(48)	26%	
Current employment salary	(24)	26%	
Federal educational grant	(10)	18%	
Federal educational loan	(0)	7%	
State educational loan	(0)	*	*Many listed more than one source*
State educational grant	(0)	*	
Scholarship	(3)	5%	
Guaranteed bank loan	(1)	*	
Private bank loan	(0)	0	
Other	(14)	23%	*Mainly GI Bill*

7. Are you active in any campus or off-campus organization or society that is concerned with marine science or technology?

Yes 36% No 64%

a. If yes, which one(s)? 16 organizations named; 4 belong to more than one.

b. If no, do you wish to be affiliated with such organizations?

Yes 85% No 10% 5% - No answer

COMMENTARY: Living on own + average age + use of savings + lack of counseling might indicate more mature individuals than normally expected of two-year student.

SECTION IV

FUTURE PLANS

8. Do you plan to make marine technology your long-term vocation?

Yes 89% No 11%

a. If no, in what field do you plan to make your career?

Describe: Nine were named.

9. Do your plans include pursuing a higher degree(s) at a university or college upon completing your present programs?

Yes 55% * No 45%

a. If yes, have you been counseled as to how this might be done with a minimum loss of credit?

Yes 48% No 52% *continued weakness in counseling*

b. If yes, by whom?

College counselor	70%	50%
College instructor	23%	33%
Parent		4%
Person in marine field	7%	9%
Other		4%

c. Will you work within the marine technology field while attending school?

Yes 77% No 20%

d. If yes, full time, (18%), or part-time (70%)?

10. If your plans do not include pursuing a higher degree immediately upon completion of your present program, will you seek full-time employment within marine technology?

Yes 86% No 14%

11. Do you intend to (1) complete your present program or (2) leave as soon as you have acquired enough training that would enable you to get a job? (Please select one of the above and check below)

(1) 95% (2) 5%

12. In the table below, please indicate by placing within the appropriate boxes (1) the year in which you plan to complete the degree(s) you are seeking, and (2) the year in which you plan to take your first full-time job. (Please mark the appropriate boxes)

Degrees	6 UnK Year to be Completed		15 UnK Year of first Full-time employ.				
	73	74	73	74	75	76	77
Associates or Certificates	42 (74%)	15 (26%)	28	8			
Baccalaureate			58	17	4 8%	5 10%	
Masters							3 7%
Doctorate							

SECTION V

EMPLOYMENT INFORMATION

13. From the following list of potential employers, select the two for whom you most prefer to work. (Please make first (1) and second choices).

	Total	(1°)	(2°)	
Federal Government	(28%)	10%	10% ←	2nd
State Government	16%	2%	9%	
Private Industry	(34%)	(20%)	6% ←	1st
Educational Institution	17%	6%	8%	
Other	5%	2%	2%	

Several did not designate which choice was 1st or 2nd.

14. Are you willing to take a job that requires you to spend time at sea?

Yes 98% No 2% Only one refusal

a. If yes, what percentage of time are you willing to spend at sea? (Please select one).

10%	(5)	50%	28% Modal
20%	(5)	60%	(2)
Median→30%	23% (15)	70%	(9)
40%	(8)	Other	(2) up to 100%

15. Have you contacted any potential employers?

Yes 48% No 52%

a. If yes, has a firm commitment for full-time employment been made to you upon completion of your program?

4 of 10 from SBCC--all others different

Yes 32% No 68%

b. If yes, with whom? Describe: 8 employers largely in private sector

16. Have you utilized the campus placement office in attempting to locate full-time employment in marine technology after completing your program?

Yes 37% No 73%

SECTION VI

ASSESSMENT

17. Do you feel that your high school program adequately prepared you to begin your marine technology program without having to do any remedial or catch-up work?

Yes 62% No 38% (24)

a. If no, did you take remedial courses?

Yes 50% (12) No 50% (12)

b. If yes, in what subject areas? (Please check below).

Math	1
Science	2
English	2
Social Science	3
Other	

Some took more than one.

18. Will your present technology program permit you to use your skills in a field other than marine science and technology?

Yes 85% No

19. What is your present assessment of job opportunities within marine technology? (Please check one).

Excellent	11%
Very Good	15%
Good	20%
Fair	34%
Poor	18%
Very Poor	2%
Non-existent	0

50% participants in diving programs, some 1st year program people

1/3 of respondents in these categories from 1 institution (CFTI). More than 1/3 of respondents plan to go on for Bachelors degree in a biology field.

a. With whom do you feel you have the best chance of finding employment in marine technology (Please check one).

Federal Government	36%
State Government	9%
Private Industry	46%
Educational Institution	7%
Foreign Industry	0
Foreign Government	2%

Consistent with listing of potential employers (Sect. V, Quest. 1)

b. Would you be willing to relocate to another region of the country or the world to secure employment in marine technology?

Yes 89% No _____

20. Do you feel that you have made a sound choice in selecting marine technology as a major?

Yes 89% No _____

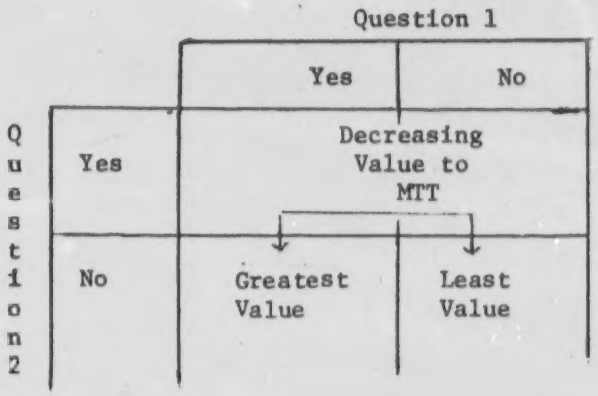
Response seems inconsistent with assessment of job market Q 19; would seem to be symptomatic of

1 - Euphoria
2a - Overzealous counseling or
2b - Lack of counseling

Student Questionnaire

Commentary
Section IV - Q 1 & 2

This pair of questions offers insight into the potential value of programs as producers of marine technicians. The program with the greatest potential value from marine technician training (MTT) perspective



is Q 1-Yes, Q 2-No, which signifies a prospective graduate of an MTT program who plans to stay in marine technology and not pursue a higher degree.

Of greater value to marine science would be a Q 1-Yes, Q 2-Yes.

An analysis of student responses by program indicates that several of the programs should be examined in greater detail for attributes which seem to offer particular value to MTT.

From the limited sample, it appears that the greatest value can be ascribed to the following programs:

Santa Barbara City College (Diving)
Highline Community College (Diving)
Cape Fear Technical Institute - General Ship Technologist
College of Marin - Sci-Tech

The programs which appear to offer more of a marine science orientation based upon a Yes/No combination are

Orange Coast College - General Marine
Fullerton College - General Oceanographic
Del Mar CC - Marine Electronics
Washington Tech Inst - General Marine/Oceans
Miami-Dade CC - Diverse

As evidenced by student expectations, the latter set must be construed as having less value as initial sources of marine technicians; nothing is expressed or implied with regard to retention. There has been some indication, for example, that retention of graduates in diving jobs is poor even though entry potential is good. Also several employers note a preference for 12-16 week speciality training in diving even though graduates seem to have no difficulty finding entry positions.

EDUCATIONAL INSTITUTION QUESTIONNAIRE

A. General Information

1. Name of Campus:

2. Name of Department:

3. Name, title, and campus phone number of person completing questionnaire: Ninety-five questionnaires were sent to colleges in 23 states and the District of Columbia; 41 questionnaires (43%) were returned.

B. 1. Does this institution currently offer occupational training in marine technology? Yes 44% No 56%

a. If yes, what marine program(s) do you offer? See Appendix A-II and A-III for examples.

2. May students earn a degree or certificate upon completing the program? Yes 90% No 10%

a. If yes, what type? See Appendix A-II for example.

3. Has this institution or will you discontinue occupational training in marine technology within the next two years? Yes 5% No 95%

a. If yes, please explain briefly: Lack of employment opportunities for program graduates.

4. Do you currently plan to initiate occupational training in marine technology within the next two years? Yes 32% No 52%
(8% gave incomplete answers)

a. If yes, briefly outline the type of program(s) you plan to offer: Examples: environmental control, work-study program in commercial fisheries, desalination program, marine construction, underwater technology, marine electronics.

b. What evidence have you that supports the establishment of such a program(s)? (briefly explain) There were few complete answers to this question, however most respondents referenced local and government surveys indicating sufficient manpower demand for new program starts.

5. Have you established an advisory committee, e.g., general or occupational, to assist in program development and related matters? Yes 90% No 10%

a. If yes, do you feel that the advisory committee has been directly responsible for any enhancement in program operations? Yes 88% No 12%

6. Over the past three years, have any significant changes been made in the program content, training techniques, etc? Yes 84% No 16%

a. If yes, please explain: Examples: curricula updating, program structural changes, course additions and deleting, overall program expansions and contractions.

7. What unique equipment, facilities, and other training aids are used in your program? (briefly mention) Examples: fishing and research vessels, chemistry, biology, engineering labs; electronic, underwater and fishing gear.

a. What would you estimate as the total dollar value of the above mentioned items? $15,887,000

b. If any of these items were donated to your program by private industry or a governmental agency please estimate the dollar value of these items: $14,453,128

8. Is your training (24%) academically or (38%) vocationally oriented? 38% both.

9. How long does it take for the average full-time student to complete your program? 66%, 2 years

10. Is your program designed to offer students training in (22%) a marine speciality, or (44%) general marine skills? 34% both.

11. Do you emphasize, (26%) land-based, or (26%) ocean-based skills development? 48% both.

12. Do you consider the marine technology skills you teach to be transferable to fields outside of marine science? Yes 100% No _____

13. In the table below, please summarize the past three years of your program regarding the number of:

    a. new student enrollment in program

    b. program dropouts

    c. program graduates

    d. program graduates who found employment commensurate with their training

    e. program graduates who found marine related employment but not commensurate with their training

    f. program graduates who continued their education at 4 year schools

    g. and the total number of students enrolled in the program for each of the three years:

Averages

Years	a	b	c	d	e	f	g
1970	39	17	15	8	2	4	59
1971	47	20	18	12	4	4	82
1972	49	18	28	24	3	5	26

Institution reporting of continuing education experience does not appear to be consistent with student expectations reported in student questionnaire.

    h. What are your current projections covering the next three years for:

(1) new student enrollment in program

(2) program graduates

(3) and, total student enrollment in the program for each year:

(Averages)

Years	1	2	3
1973	58	30	90
1974	66	26	107
1975	73	44	129

14. By whom have the majority of your program graduates, finding marine related employment, been hired?

8% Federal government

12% State government

52% Private industry

16% Academic institutions

12% Other: _____

15. What percentage of graduates finding marine related employment were hired by local employers? 49 %

16. Do prospective employers representives regularly visit your campus to recruit marine technicians? Yes 35% No 65%

a. If yes, which of the following visit more (check one)

_____ Federal government

14% State government

57% Private industry

29% Academic institutions

_____ Other: _____

17. Are any special efforts made by program administrators and by staff to secure marine related employment for program graduates?
Yes 89% No 11%

a. If yes, please explain briefly: Most respondents indicated they maintain personal contact with employers and their students obtain formal placement assistance through the campus placement office.

18. For which of the following geographic areas is your program designed to provide marine technicians?

18% Locally

18% Statewide

28% Regionally

26% Nationally

8% Internationally

2% Other: _____

19. Is your program designed around the manpower needs of any specific employer? Yes 21% No 11% (51% saw no conformation)

a. If yes, who: Most respondents indicated private industry as the specific employer. Government agencies were also mentioned.

b. Any specific employer group?

25% government, 50% private industry, 13% academic institutions

4% other: 8% none

20. What is your assessment of the correct job market for marine technicians, nationally, statewide, and locally?

	Nationally	Statewide	Locally
Excellent	16%		
Very Good	21%		6%
Good	26%	52%	22%
Fair	26%	29%	22%
Poor		6%	33%
Very Poor	5%	6%	6%
Non-existent	5%	6%	11%

This does not seem to be consistent with poor employment opportunity noted in Q B-3.

21. What percentage of your overall program funds are derived from <u>special grants</u> from state, federal, and private sources? 49%

EMPLOYER QUESTIONNAIRE

COMMENTS

Of the 1,567 questionnaires sent to employers (private industry 1,452; government agencies 110; educational institutions 105) a total of 395 (24%) were returned. For the most part, responses to the survey questions were satisfactory; however, there were incomplete responses to a few items, which made data tabulation in most cases cumbersome and incomplete. Questions 2, 2a, and 3 to a large extent reflect very rough estimates of the total data given in response to these items. An attempt has been made to identify more reliable figures as they related to these items. Sections III & IV of the report present a more detailed account.

SECTION I

1. Organization Name: A total of 1,667 questionnaires were

   Address: sent out (private industry, 1,452; government

   agencies, 110; educational institutions, 105).

   Phone Number: The total return was 395 (24%).

2. Name and title of person responsible for completing questionnaire:

   Name: _____

   Title: _____

3. Please describe the general nature of marine activity in which the organization is involved:

   _____

   _____

   _____

SECTION II

1. Are marine technicians employed by your organization?

   Yes 24% No 76%

   a. If yes, in the following table would you please summarize your organization's hiring history of marine technicians over the past three (3) years by

      (1) indicating the job titles under which they were hired;

      (2) the number of persons hired in each job category;

      (3) achieved educational level at time of employment

      (See table on next page)

Hiring History

Year	Job Title	Associate or Certificate	Baccalaureate	Masters
1970		100	99	21
"				
"				
"				
1971		119	106	14
"				
"				
"				
1972		107	193	41
"				
"				
"	Totals	326	398	76

b. In the following table would you please estimate what your future manpower needs will be for marine technicians.

Hiring Forecast

Year	Job Title	Associates or Certificate	Baccalaureate	Masters
1973		105	31	17
"				
"				
"				
1974		105	106	8
"				
"				
"				
1975		112	95	8
"				
"				
"	Totals	322	232	33

2. a. How many persons are currently employed by your organization?

2000 (see comments)

b. What is the current ratio of technicians to professionals, i.e., physical scientists, engineers, etc.

Ratio: 1:10 (see comments)

3. In the following table would you please indicate the total number of persons employed by your organization by category:

Category	Number
Physical Scientists	96
Social Scientists	42
Engineers	221
Formally Trained Marine Technicians	28
Non-Formally Trained Marine Technicians	97
Managers and Administrators	147
Others:	210
Others:	
Others:	

4. Does your organization have a job classification "marine technician?"

Yes 10% No 90%

5. Have your educational requirements increased for technical paraprofessionals over the past three (3) years?

Yes 28% No 72%

6. Have you experienced any difficulty in recruiting formally trained marine technicians?

Yes 18% No 82%

7. What is the average starting salary for your marine technicians?

$ 7,416.00

8. Have you ever been contacted by a representative of an educational institution for the purpose of discussing your technician manpower and training needs?

Yes 33% No 67%

a. Do you maintain liaison with an educational institution(s) that offers a marine technician training program?

Yes 18% No 82%

b. If yes, please name the institution(s) below:

_____

c. Do you recruit marine technicians from this institution(s)?

Yes 10% No 90%

d. If yes, have you found the training provided to be adequate for for your needs?

Yes 51% No 49%

e. How do you make your technician manpower requirements known to educational institutions? (Please check one).

Faculty Members	32%
Campus Recruiting Trips	17%
School Administrators	18%
Media-Advertising	28%
Other: _____	5%

9. Does your organization encourage employees to take extended education courses in marine technology?

Yes 33% No 67%

a. Do you provide any type of financial aid to your employees who take extended courses in marine technology?

Yes 43% No 57%

10. Have you recommended to any local educational institution(s) that they initiate a program in marine technology?

Yes 20% No 80%

a. If yes, what institution(s)? Please list below.

No schools were identified by the respondents.

b. What type(s) of marine technician program(s) did you recommend? Please list below.

Underwater technology. Examples: Engineering technology, fisheries technology, environmental technology, clinical technology - a total of 11 program were recommended.

c. Was the program initiated?

Yes _____ No _____

Four (4) of the eleven (11) programs recommended were initiated.

11. Generally, how do you see present employment opportunities for marine technicians? Please check.

		Private Ind.	Gov't Agenc.	Ed. Inst.
Excellent	( )	5%	4%	2%
Very Good	( )			
Good	( )	24%	34%	34%
Fair	( )			
Poor	( )			
Very Poor	( )			
Non-existent	( )	27%	27%	2%

A detailed analysis was performed by industry segment of 50 responses to the mail query. The study showed that 11 activities were represented, the 6 most prevalent being

Research (10)
Instrumentation Developers and Manufacturers (8)
Geophysical Survey (6)
Naval Architecture and Marine Engineering (6)
Equipment Manufacturers (6)
Analytical Services (5)

where parenthetic numbers signify frequency of occurrence. The remaining 5 were

Diving Services (4)
Aquaculture (2)
Ship Repair (2)
Field Service/Ship Operations (1)
Manufacturers Representative (1)

At least one firm in every category hired "marine" technicians. Most indicated they hire some AA's; however, the term "technician" was also applied to employees with master's degrees. Three of four responding Diving Service companies did not classify Divers or Diver Tenders as marine technicians. There were no clear patterns that emerged as far as the use of technicians was concerned, although it does appear that Naval Architects are least likely to use the job title; draftsmen used by Naval Architects, while not called technicians, were included as such in the P/T ratio.

With the exception of Diver Service companies (if Divers and Tenders were classed as Technicians) the ratio of technicians to professionals (T/P) seldom exceeded 1:1 (only 7 times out of 43) and then the maximum was 3.5:1. In 18 cases the ratio covered the interval between 1:1 and 1:1.99 (the most frequent value was 1:1--14 times). In only three cases was the ratio less than 1:5. The predominance of

ratios slightly less than 1:1 is consistent with historical precedent (Ref. 26).

Where then did the figure of 3:1 used by Benson (and alluded to by others) come from? This subject is discussed further in the next section.

It would appear that segmentation of data by industrial characteristics must be a consideration in any future surveys, if an improved understanding of the role of the marine technician is to be achieved.

Part IV

ASSESSMENT AND SUMMARY

Supply and Demand

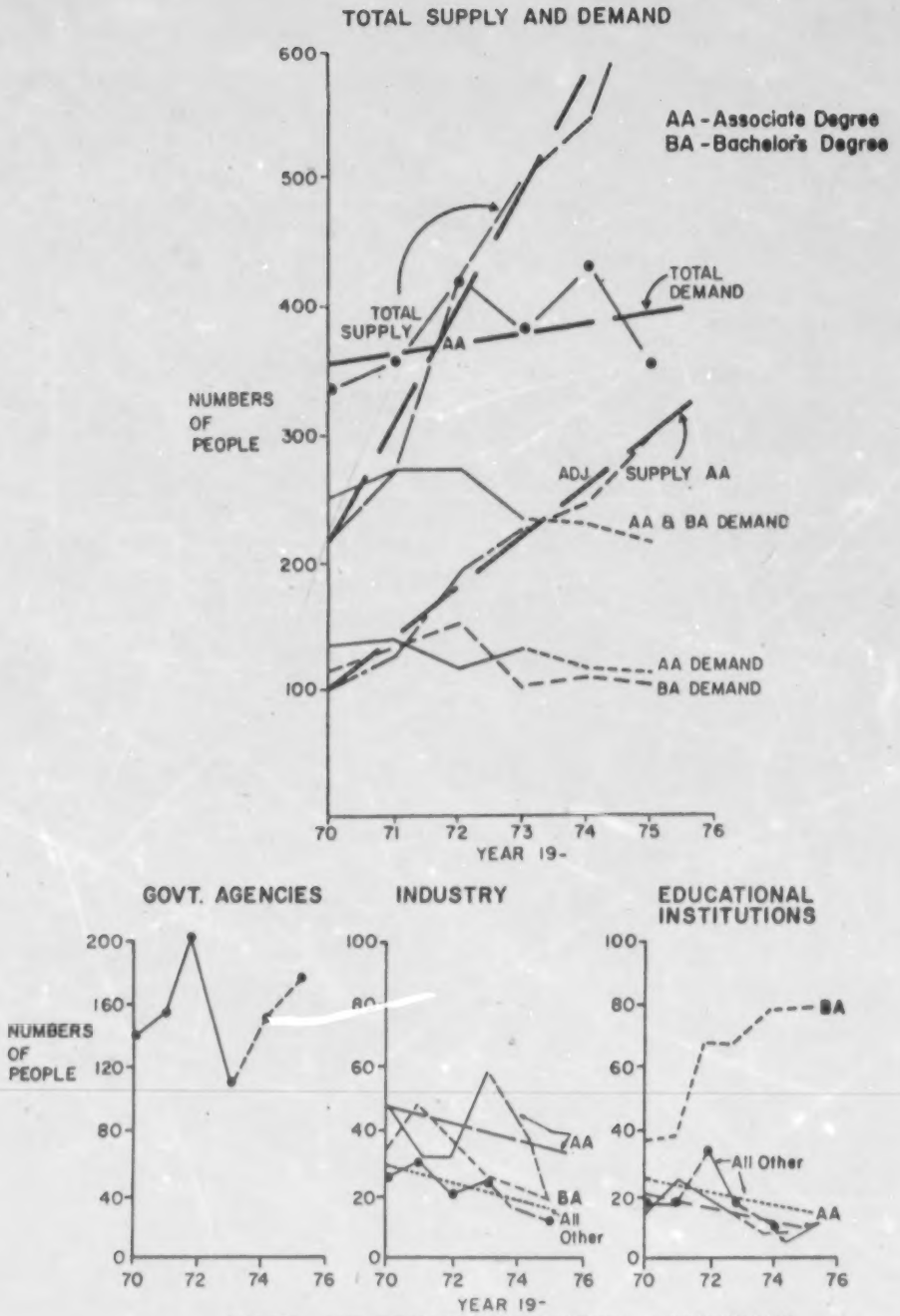
As stated earlier in this document, the problem of acquiring information with which to analyze supply and demand continues unsolved. Industry as a source of information has been extremely difficult to analyze because the fraction contacted is so uncertain. The I.O.F. (International Oceanographic Foundation) survey of 1967 for example, was estimated to have covered 10% to 50% of the total population of oceanographers employed by industry. Forty percent was used as a "best" guess.

The broad dimensions of the Supply-Demand problem are captured in comments such as the following (Ref.10):

> Demand - Business men expect a 10-year doubling time for personnel requirements in almost all categories.
>
> Supply - Educators predict a 3-8 year doubling time in faculty and enrollment depending on field and curriculum.

Figure 1 illustrates the magnitude of the discrepancy found in this survey between the number of marine technicians recently trained and the number of jobs available to them as program graduates. If the data are to be believed, demand will double in 34 years while supply will double in about 5.

The figure, although based on questionnaire data, is still thought to understate the contention that marine technician training programs are in a state of overproduction because:



SUPPLY AND DEMAND FOR MARINE TECHNICIANS

FIGURE I

--Data used to chart this figure were obtained from the assessment study's questionnaires to educational institutions and employers. While 34 training programs have been identified by this study, only 18 contributed to the data used to build the figure. In addition, students of many nonmarine programs could fill the jobs reported by industry. Those leaving the maritime military services and vocational-technical high school programs also form part of the labor pool from which these jobs could be filled.

--Employers answering the questionnaires reflected their uncertain understanding of the nature of trained marine technicians by providing hiring histories and forecasts that were exceptionally difficult to work with. When asked to identify marine technicians employed by their organizations, respondents included such classifications as Vice President, Naval Architect, and Geologist.

For the purpose of developing Figure 1, AA and BA level marine technician jobs were culled from the histories and forecasts as accurately as possible. However, the point remains that employers exhibit confusion when discussing job classifications for trained marine technicians.

The report of Government Agencies which is found on the lower left of Figure 1, can be misleading if interpreted in the same light as "Industry and Educational Institution" employers. One factor in particular must be considered:

The Coast Guard, a major contributor to both supply and demand, operates its own training units, and as such does not constitute a demand for the products of marine technician training programs in the same sense as the others. In fact it is a competitive source of supply.

The report of Industry must also be treated with care because, as is frequently the case with industrial projections, repetitive sequential forecasts show that near term predictions tend to be conservative.

Frequently, therefore, a level estimate in the 1-3 year forecasting period is a quite accurate expected value.

The net effect of all of the factors developed as a result of the survey is that schools may be preparing students for jobs that employers do not recognize, a point that has been elaborated in several studies of the marine technician training community. Further implications of such weaknesses in educational institution-employer communication are discussed later in this section.

In addition to the clear indication given in Figure 1 that for the present and near future the supply of marine technicians may exceed the demand, the following should be noted:

> *--Six months after publication of his 1968 monograph projecting employment for 43,000 marine technicians Dr. Chan revised his estimates downward by 78 percent. While strongly supporting technical-vocational training programs, Chan concluded that marine technology curriculums should be free to develop into four-year degree programs (Ref. 7).*
>
> *--Rechnitzer (Ref. 19) stated that "for many professions a great deal of historic data on manpower, education, training, and job titles and descriptions are available which lead to reasonably accurate forecasts of the need for personnel. Such information does not exist in the field of marine sciences."*
>
> *The report advocated a period of curtailment of growth; this time was to be devoted to much-needed evaluation. As a result, the California Coordinating Council for Higher Education resolved to advise the Office of the Governor to communicate to the Office of Sea Grant that "In order for the state to use prudently the funds available to higher education, the Office of Sea Grant is urged not to approve applications for Sea Grant funds for the initiation of new education programs in California unless the application carried Council endorsement."*

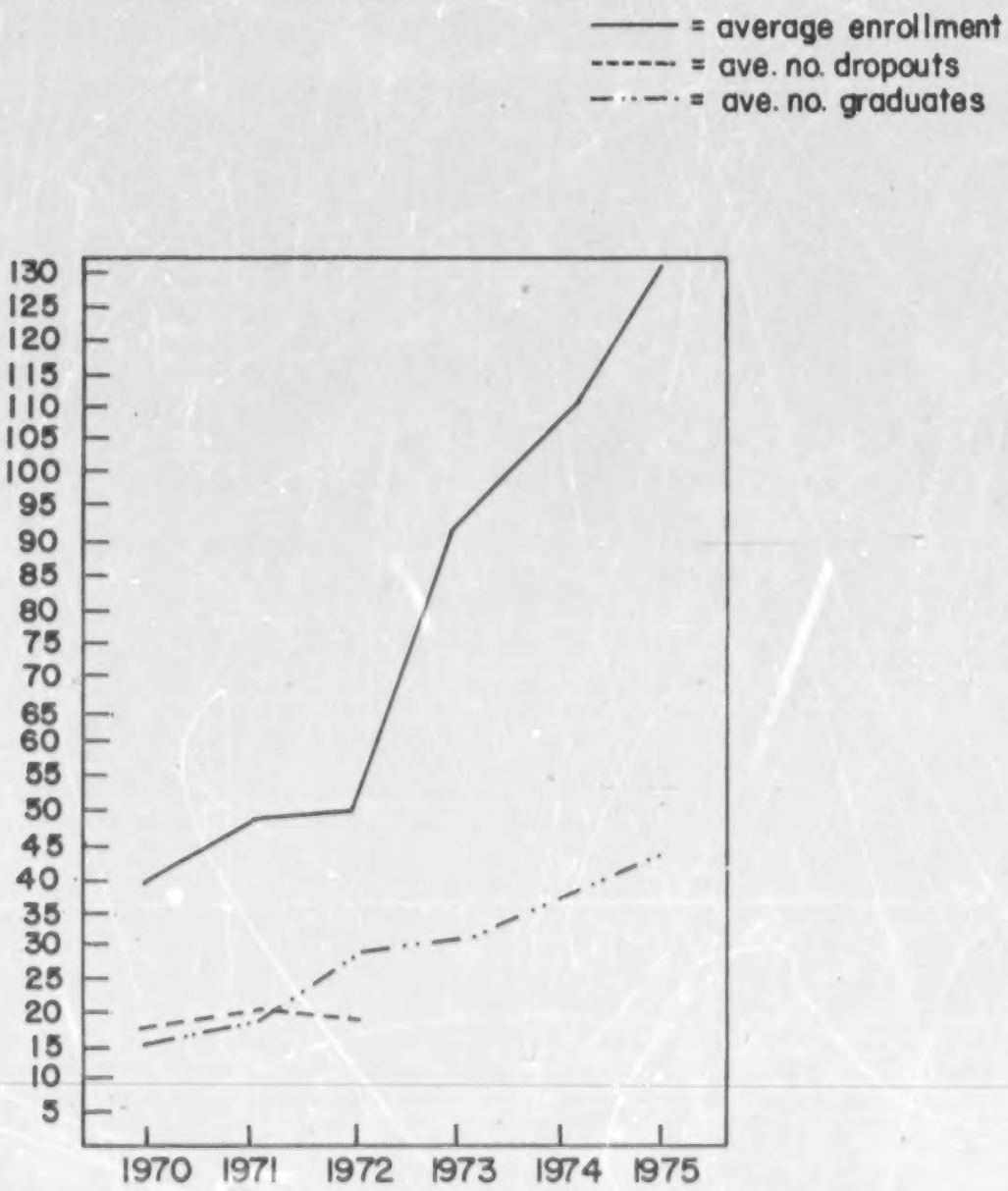


Fig. 2
MARINE TECHNICIAN TRAINING PROGRAMS:
AVERAGE ENROLLMENT, DROPOUTS, AND GRADUATES
1970 - 1975

--Heinkel (Ref. 13) showed that more students were being trained as marine technicians in the San Diego area than there were jobs available. Statistics from former students pointed out that less than one-third of these graduates of marine technology programs were employed in a marine or marine-related industry.

--In 1972, the Board of Governors of the California Community College took action to curtail program expansion.

--In 1973, marine technician training program directors voiced strongly, concern over a student placement at East and West Coast workshops (see Part II).

Despite the fact that the job market for marine technicians has been considered soft at least since 1970, enrollments in training programs increased sharply from 1972 to 1973, and will probably continue to increase in 1974 and 1975.

Figure 2 compares the climb of average enrollments with average numbers of graduates and dropouts. The data are presented in Table A-IV-1. Note that the dropout rate was not projected beyond the present, and that there is a time lag, generally of two years, between time of enrollment and time of graduation.

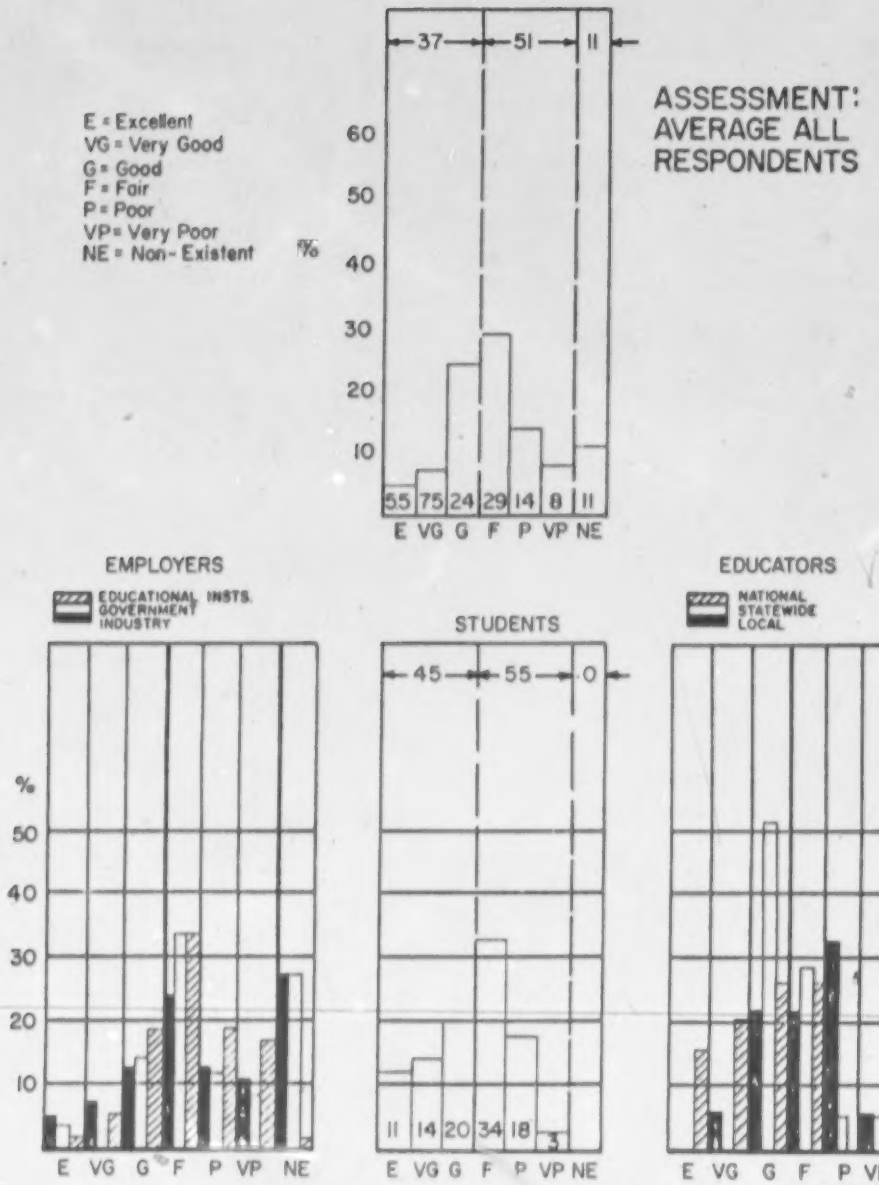
The more than 300 percent average rise in enrollments from 1970 to 1975 would seem to indicate several possibilities - (1) That despite pessimism voiced at the 1973 workshops and on other occasions, program directors are optimistic about the job market; (2) A reluctance to manage program reductions after the hard sell that initiated them; or (3) The local picture of employment opportunities is quite different from that for the nation and region - the latter two being more pessimistic. The last is clearly not the case based on the data.

In Figure 3 which illustrates the responses of students, educational institutions, and employers when asked their opinions of the current job market, averages are presented for all respondents.

The ability to relate national projections to local conditions continues to be difficult, in part, because of divergence of assumptions and in part because of the effect of local concentrations (Ref. 18).

Certain of the marine technician occupations and consequently training programs have a strong orientation toward satisfying local needs while others are more nationally oriented. An analysis of graduate placement indicates, for example, that 80% of the graduates of diving programs (49 graduates from two community colleges in '70, '72, and '73) were placed in jobs out of state, whereas commercial fishing and fish and game technology place about 90% of those entering the job market in the local area or region. An extraordinary high proportion of these in fish and game technology (40% by one, 30% by another) transferred to 4 year college programs. Graduates of curriculums in Vessel Operating Training and in Oceanography split roughly 50/50 between local and out of state employment. One Engineering Technology program in the Gulf Coast area provided an interesting employment picture for a 12 member class. Although 9 members of industry made job offers, one company made offers to 11 of the class and hired 8. Predictions of future employment potential in situations such as this must be made with great care.

Unquestionably the assessments of Figure 3 reveal more optimism on the part of educators than on the part of the other group. Where the question applies to the local market, however, the optimism is considerably



ASSESSMENT OF JOB MARKET

Figure 3

tempered, the local perception of the more remote markets being more favorable. Because of the role played by advisory councils and surveys of local needs, it is fair to assume that educators are more familiar with the local market than with the statewide and national markets. Unfortunately the significance of this difference of perception relates to the uniqueness of a particular program, i.e., one-of-a-kind programs are not adversely affected, whereas common programs compete for opportunities that are always in someone else's backyard. Symbolically (and actually) Figure 3 shows the student squeezed between pessimistic employers and optimistic educators.

The following assessments of the demand for marine technicians by others should be noted:

> *--Marine science students polled by Rechnitzer seemed less optimistic than our marine technician students. Forty-two percent felt that few job opportunities existed, 22 percent believed that job opportunities were in balance with the current supply, and 22 percent believed that jobs exceeded the supply of trained manpower.*
>
> *--In his 1973 dissertation, Kennith G. Gordon stated that the total number of available marine technical personnel for sea-going positions was at least a number equal to the available jobs. Taking into account marine technicians trained at two-year institutions, as well as maritime military personnel leaving the service, and his estimate that there are annual job openings for as few as 100 seagoing technical personnel, he concluded that the job market was at or near the saturation point.*
>
> *--M. Karl Jugel, in a recent analysis of civil diving in the United States, stressed that the decision to pursue a career in diving should be considered more carefully. Graduates of diving programs are finding more employment opportunities in the recreational field than in the industrial and research fields. Jugel encourages training program directors to be more realistic in their job counseling of students.*

In the light of these results and comments, one can reasonably ask "When does a program conceived in response to need (real or theoretical) become a missionary marketing effort to save an ill-conceived project, with careers and people as the commodity?"

The analysis of the collected data indicates that the weakest link in assessing the status of the marine technician is the demand side of the employment picture. Foremost among the indicators were the following:

- -The overall questionnaire return rate (22%) was too low to make a reasonable assessment of the long and short range demand and supply equation for marine technicians. Many of the questionnaires returned were missing entire sets of information which made rigorous data analysis an impossible task.

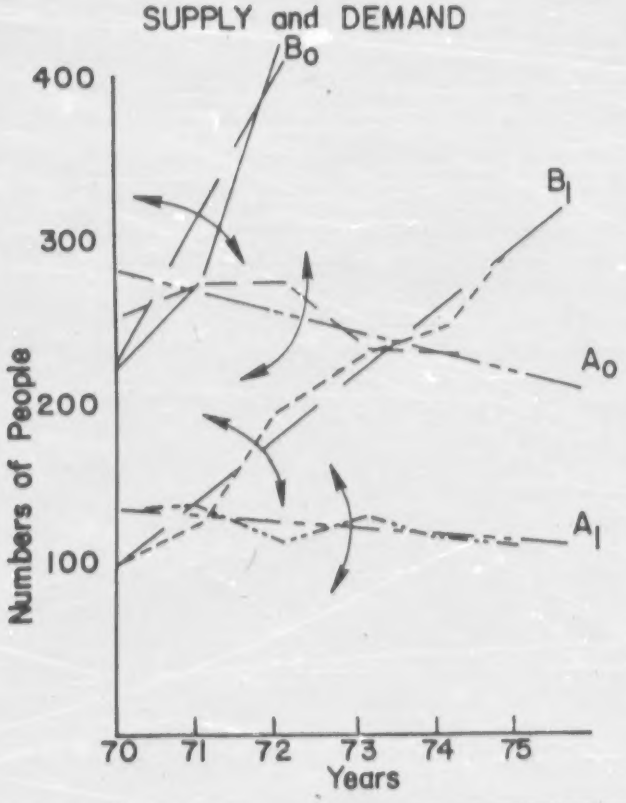
- -The overall questionnaire response from the private industry sector was too low (20%) and by and large incomplete. It is felt that much of the demand for marine technicians still eminates from the private sector as evidenced in an earlier study which indicated that 75% of all technicians are employed by industry (Ref.26). It is therefore vital that a much stronger data base be established before the impact of this factor can be properly assessed one way or the other.

- -Approximately 10% of the questionnaires sent to private industry were returned because of incorrect addresses, with no forwarding addresses available. These questionnaires were discounted in the tabulation which lessened the data base significantly.

- -The population from which the sample of marine employers was drawn originally should have been much larger - a significant number of potential marine or related employers were not included in the original survey. This is primarily a result of a lack of available information identifying marine industry components.

- -The data supplied by employers related to marine technician job descriptions was very incomplete. This has hampered progress in establishing a picture of marine technician occupational structures.

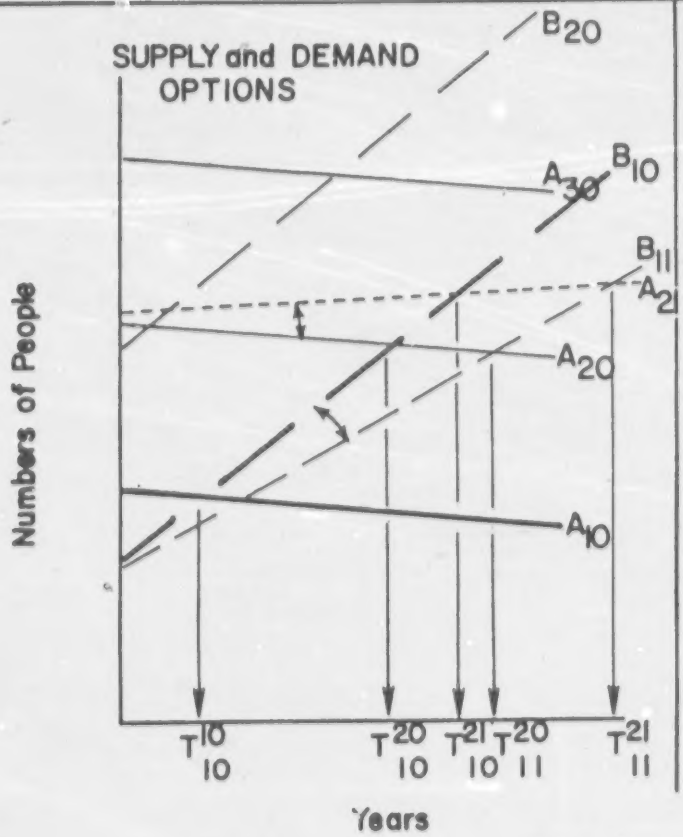
Figure 4 provides a summary of the data previously described in greater detail in Figure 1, and poses several problems whose answers are key to adequately assessing the status of MTT.



B_0 unadjusted supply: 2-year graduates
B_1 adjusted supply: 2-year graduates entering job market
A_0 BA & AA combined demand
A_1 AA demand

Possible conclusions from data: Adjusted supply far exceeds demand but two significant questions remain to be answered:

1) What forces can change slopes of supply and demand lines?
2) What is the correct level for supply and demand lines?



Some of the options, given that there are forces for change are:

1) Typical forces for changing
   A. the demand function
      a) for same slope: proportion of population accounted for
      b) for different slope: representativeness of population of users, job definition, and other sources of prospective employees
2) Typical forces for changing
   B. the supply function
      a) for same slope: proportion of population accounted for
      b) for different slope: change in proportion of dropouts and transfers

Each option can result in a different crossover point for supply and demand.

Figure 4

The Data Problem

First is the problem of the inability to identify industries which employ technicians through any simple criterion such as Standard Industrial Classification (SIC). This difficulty is compounded by the absence of a clear association between requirements for marine skills and job titles,which affects the reporting of employment information. Also a part of this problem is the proprietary nature of data, which for many companies precludes obtaining sales or other forms of activity information with which one might forecast a need. The second problem is the lack of uniformity of the definition for a technician. Third is the lack of visibility into the attitude of employers toward the role of the technician, and relative value of the graduate of a 4-year program vis-à-vis the graduate of a 2-year program. This difficulty is further complicated by the inability to quantify the comparative preference of industry for OJT vs. academic training. The last problem is the structure of marine industry itself which appears to have either very small or very large participants. In the latter case, completely frustrating to the analyst is the inability to find one's way through the maze of the organization chart to the source of appropriate data in the large and/or multi-divisional corporations.

Identifying Industries that Employ Marine Technicians

Defining employment markets has long been a problem in evaluating occupational training opportunity. From personal observation, conceptually, the pressure for technican training programs appears to pass from local problem situations up to the federal level via Associations or other

constituency pressure groups giving impetus to programs initiated at the region, state, or local level. The origins of the ground swell which createsthe demand for a program seem to derive from a number of sources -- large multi-divisional corporations, government bureaus, and the wishful thinking of countless entrepreneurs who ride the initial waves of a new emphasis or technology, but then frequently drop out along the way (as possibly illustrated by 11% undeliverable survey forms and the claims of several respondents that they weren't really part of the marine industry).

The assessment of employment demand at the state and local level has long been a requirement associated with educational program planning. Norman C. Harris (Ref. 9) notes that "Prior to initiating occupational education curricula or courses, two essential steps are necessary: (a) determining need, and (b) determining capability. He noted that comprehensive occupational surveys were required to determine local needs of employers (not necessarily the same as needs of local employers) followed up by spot surveys to explore specific cases. In the chronology of the decade of enthusiasm described by Martin D. Brown (Ref. 3), the repeated phenomenon of the overly optimistic demand forecast in the late 60's illustrates the need to place these forecasts in correct perspective with the realities of economic growth and federal support. The translation of locally perceived demands into a larger coherent national picture of manpower requirements therefore also appears to be a part of the data and demand evaluation problem.

In an effort to improve the industry data base, responding industry groups were analysed for SIC categories. Conceptually, the reason for the emphasis upon SIC coding, is to develop a basis for

projecting demand through associated sales, payroll, value added, or other similar statistics descriptive of business activity. The study indicated that the primary groups identified in Table A-V-1 were represented. However for the several reasons that follow, the question remained unanswered as to the proportion of total demand represented by those responding. First, most of the SIC's involved are not uniquely associated with marine activity. Second, many of the companies are privately held, therefore information concerning operations is not usually published. Third, the field of prospective employers was not adequately covered; the market segment constituting the Offshore Petroleum Industry for example, was not adequately represented in the original mailing. In order to improve industry representation, the list of prospective employer contacts was expanded to include those in Table A-V-2 and subjected to a similar analysis of SIC classifications. The sources of expanded information included Sections A, D, and E of Undersea Technology Handbook, 1971-72 Directory, and World Wide Directory, Offshore Contractors and Equipment, 1973.

Data on few of the companies that augmented the original list were to be found in open literature, nor were company representatives who were contacted by phone or visit willing to discuss sales or other activity information.

The additional activities by no means exhausted those who were potential (not prospective) employers of marine technicians. For example, only 16 of 28 major geophysical service companies were included; in the category of transportation service (logistic support) only a few of the more than 100 companies were represented, most of which are closed

corporations, partnerships, or individual proprietorships. Also conspicuous for their absence in the industrial picture presented are commercial fishing, food processing, recreation, and general marine transport. In the case of the last it was felt that their manpower and training needs were reasonably well understood and largely catered to by specialized training institutions.

Lack of Uniformity of the Definition for a Marine Technician

The second complicating factor affecting demand, is inadequate definition of the term marine technician. This is caused in part by the indiscriminate use of words such as technical (Webster: of or pertaining to the useful or mechanical arts, or to practice, method, procedure, etc. in any science, business, profession, sport or the like) and technician (Webster: one skilled in the technical details of a trade, profession, subject, art etc.; a technical expert). Chan on one hand (Ref. 5) accepted a definition derived from a set of 5 general abilities suggested by the U. S. Department of Health, Education and Welfare (Ref. 8) for any person holding a technical job which is modified by an environmental emphasis. The definition was so broad, however that environmental considerations were virtually eliminated as a selection factor, e.g., an ocean technician (undefined) was equated in classification to an electronic technician working on marine activities. Martin Brown (Ref. 3) and Richard Benson (Ref. 2) among others have perpetuated this extreme generalization.

Other typical definitions and their sources include

'Do you prefer to work with your hands?

·Are you happy doing active things, and miserable doing skull work over endless papers?

·Then perhaps you're a technician.

-Pacific Sea Grant Advisory Program
No. 3
"Today's Youth in Tomorrow's Sea"
(Ref. 27)

"While the job of skilled craftsman depends primarily on his manipulative ability, the manipulative ability of the technician mainly aids him in applying scientific and technical knowledge to a particular technical problem. The major occupational groups are: draftsmen, engineering technicians, physical science technicians, and life science technicians."

-The Technical Manpower Shortage
How Acute?
NICB
(Ref. 26)

Benson (Ref. 2) conceptualizes a technician as filling the gap between craftsman and engineer caused by increasing complexities of technology.

Angel (Ref. 28) notes that the term technician has no generally accepted definition. The title may reflect technical level, work activity, or discipline. As used in the reference, it refers to technical workers whose job requires

·Knowledge and use of scientific and mathematics theory

·Specialized education or training in some aspect of technology or science

.Working directly with scientists and engineers

Harris (Ref. 9) defines "Occupational education" to include semiprofessional, technical, and skilled-level curriculums for all fields of employment, and proceeds to define "Technician education" as a subset which

·Is organized into two-year programs at the college level

·Emphasizes work in the field of science and mathematics

- Gives much attention to technical knowledge and general education but also stresses practice and skill in the use of tools and instruments
- Leads to competence in one of the technical occupations, and usually to the granting of an associate degree, and
- Includes a core of general education courses up to perhaps 1/4 of the total credit hours

The variability of technical competence implied by these diverse descriptions of a technician is very great. It is no wonder that confusion exists about the extent of demand. Within the same context of marine technician training for example there exist curriculums for Commercial Fisheries Technology, Underwater Welding Technology, Marine Science, and Electronics Technology. It is hardly likely that these in any way whatever satisfy the same set of definitive criteria.

Paralleling the problem of defining marine technicians is the associated problem of defining occupation clusters. Between 1968 and 1973 there have been at least the three interpretations provided in Table 4, although during that time almost exactly the same skills have remained closely tied to the marine environment by virtue of occupational dependency, i.e., fishing operations, marine transportation operations, diving, marine construction and the conduct of ocean survey operations.

A fourth column has been added to Table 4 which lists only these bare essentials as proposed occupational clusters. It seems reasonable that from these 6 items singly or in combination (as illustrated in Figure 5) one can derive marine <u>dependent</u> clusters rather than those which are only marine <u>associated</u>.

Marine Occupation Fields
Table 4

Period* / Year / Author	Unrestrained Optimism '68 Chan	Shakeout '71 Gillie & Pratt	New Horizons '73 Farming	Bare Essentials '74 Mitchell & Goodman
	1 - Oceanography	Marine Environmental Management	Research	Ocean Survey Opns.
	2 - Scientific Research			
	3 - Aquarium Management			
	4 - Aquaculture	Aquaculture Opns.	Fishing & Fish Farming	Fisheries Technology & Opns.
	5 - Fisheries Technology	Fishing & Seafood Processing		
	6 - Seafood Processing			
	7 - Natural Products	Mining & Chemical Extraction		
	8 - Marine Oil Exploitation & Mining	Offshore Petroleum & Natural Gas Prod.	Petroleum & Natural Gas Exploration & Extraction	
	9 - Hardware Technology	Sea Craft Opns.	Merchant Marine Activities	Ship Opns. & Maint.
		Sea Craft Maint.	Tugboating	Boat Opns. & Maint.
		Sea Craft Maint.	Ship Construction	
		Recreation	Harbor Const. & Maint.	Marine Const. & Maint.
			Longshoring	Diving

*Author's Interpretation

The Attitude of Employers Toward the Role of the Technician

As noted earlier, Industry is the major employer of technicians - 75% is the estimate (Ref. 26). Of this number, it has been variously estimated that 50 to 74% (Ref. 20 and Ref. 13) are provided through OJT, walk-ins, servicemen, or upgrading, while others (Ref. 25) claim that employers generally prefer to have persons who have acquired their knowledge at a technical institute or college. The attitude of employers toward formally trained marine technicians therefore appears to be mixed. In some situations, particularly under circumstances of local need, prospective employers, or special interest groups such as industry associations, have requested the initiation of special vocational education programs. The National Association of Engine and Boat Manufacturers, for example, requested Middlesex Community College to conduct a pilot 16-week course in "Marina Service Management." Similarly the College of Redwoods (West Coast) in response to local needs created speciality programs for "Fisherman" occupations and "Seafood Processor" occupations, even though most firms in a 1973 New York survey (East Coast) of marine job opportunities (Ref. 21) indicated such training usually takes the form of OJT.

Based on the survey, there appears to be very little effort on the part of Industry to discriminate between technicians on the basis of shore based or marine capability. The attitude of several respondents typically indicated that if a marine orientation was needed, they would provide it through on-the-job training. There is no large movement toward establishing marine technician job titles (Ref. 7).

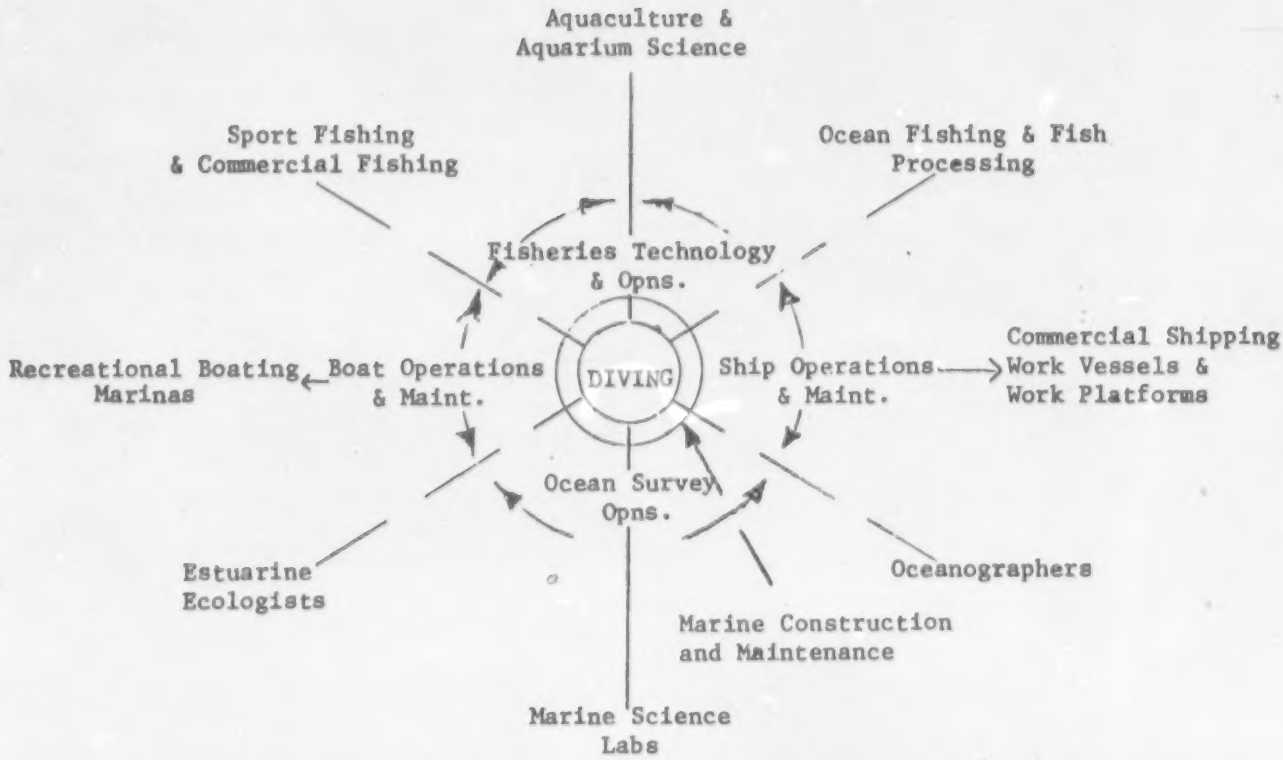

Aquaculture &
Aquarium Science
Sport Fishing
& Commercial Fishing
Ocean Fishing & Fish
Processing
Fisheries Technology
& Opns.
Recreational Boating
Marinas
Boat Operations
& Maint.
DIVING
Ship Operations
& Maint.
Commercial Shipping
Work Vessels &
Work Platforms
Ocean Survey
Opns.
Estuarine
Ecologists
Oceanographers
Marine Construction
and Maintenance
Marine Science
Labs

Figure 5

There is evidence however, of attempts on the part of educational institutions to have the term "Marine" attached to as many occupations as possible, perhaps in hopes that this will lend credence to optimistic demand estimates (Ref. 29). A number of survey respondents volunteered the information that the products of general (marine technician) programs in their experience were inept in the marine environment. Comments with respect to speciality programs such as diver training on the other hand, were very favorable, although the users surveyed indicated that new employees spent up to two years as diver tenders even though they were graduates of diver training programs.

The attitude of the large multidivisional corporation toward formally trained marine technicians is somewhat influenced by the flexibility they have to cross-train personnel through internal training programs. Twenty years of personal experience of one of the authors of this report with one such company has led to the recognition that the decision to hire a graduate of a 4-year (or more) program or a graduate of a 2-year technician program may be indictive of prestige and long-term potential rather than economics and immediacy of need. Recognition of this attitude was also expressed by the Commander of the U. S. Navy Oceanographic Office in a letter of 5-19-69 to H. Goodwin of OSGP. Capt. Treadwell noted that the reluctance to use marine technicians may relate to prestige factors which are greater for Ph.D.s than technicians, so one hires Ph.D.s.

The economics of manpower utilization is another factor contributing to employer attitudes regarding the use of technicians. This frequently

leads to an apparent overlap between degree holder and technician activities and is attributable to the relative difficulty of sea vis-à-vis land operations, and is further complicated by the nature of marine activity which requires that many marine scientists and engineers spend a large part of their time on land. In this operational situation, economics dictates that marine specialists gainfully employ their time with more mundane shoreside activities. This frequently results in overlapping the province of the technician, thereby displacing the latter. The Marine Technician Series of job descriptions (U. of Cal. 1967), which prefers a minimum of bachelor's level education, and rewards a master's level by a higher entry step is one example of the competitive situation facing a technician. For the higher educated man, the entry job can reasonably be treated as a stepping-stone to greater responsibility and opportunity, and at the same time assures, through replacement, a continuing renewal of competence at the highest current state of the technical art. Except in very high production operations one should seriously question an industry employment strategy that would utilize an abundance of formally trained marine science technicians.

The Structure of Industry

There is only one aspect of the structure of marine industry which remains to be discussed at this point: the lack of opportunity for the marine technician.

To state it simply, incentive to become and remain a sub-professional general marine technician is wanting. A large proportion of graduates in most of the recent surveys has indicated a desire to pursue further educational objectives (as high as 75-80% according to Ref. 5). A number

of survey industry respondents indicated that they support self-improvement efforts of their employees, if appropriate to their job requirements, by sharing in the costs of education.

Dr. Richard Geyer of TAMU (Ref. 16) noted that the long-term career potential for narrowly trained marine technicians is limited although it isn't clear whether narrowness is a matter of program length or curriculum. In either case this is a factor which unquestionably contributes to the decision of many to pursue further education. It should be noted that the statement is fundamentally inconsistent with the experience of vocationally trained marine technicians.

The overall trend in continuing education for the AS graduate is neatly summarized by the following statement from Harris (Ref. 9):

> With increasing frequency these days, the community college graduate, after working for a time thinks of continuing his education. His employer may suggest it, better job opportunities which require further college work may beckon or having proved his scholastic ability by attaining the associate degree the individual may now desire further education with the baccalaureate degree as the eventual goal in mind.

If the challenge to the general marine technician is there, then one should hardly expect him to be satisfied with limited opportunity. It should not be surprising therefore if Bachelors level candidates accept entry positions at the level of technician competence, but with an eye to the future.

Institutional-Employer Involvement

Frequent mention has been made in several reports of the need for surveys as a basis for training program definition. The workshop participants on the other hand placed much greater emphasis on direct contact with the job market through advisory committees or councils.

In either case contact with the job market is surely a necessity in order to develop suitable programs responsive to needs and to place students.

It is interesting therefore to examine the responses to four of the questions concerning institutional-employer involvement addressed to each of the three groups of employers. As shown in Table 5:

> *--Only 10 percent of respondents from industry hired marine technicians; only 8 percent of these had job classifications for marine technicians*
>
> *--None of the employer groups reported serious difficulty in filling technician-level jobs.*

Most marine technician training institutions have formed an advisory council to keep informed of the needs of industry and other employers. However, the lines of communication opened through the councils and through personal faculty-industry contacts do not appear to be adequate.

Another aspect of the communications problem was clearly shown by Heinkel (Ref. 13) who compared skills thought to be most important by training institutions with those considered essential by industry. Results indicated that employers called for more training in mathematics, electricity, office equipment, machine shop, design engineering, data handling, and diesel technology and repair. They were less interested than the instructors were in the following areas: biology, optical equipment, photography, geology, and meteorology.

The extent of contact with training institutions reported by the three employer groups is shown in Figure 6. The contacts range from only superficial to the ultimate - the employment of graduates of marine technology programs. The figures are based on a varying number of responses to each question.

Table 5
EMPLOYERS AND MARINE TECHNICIANS

I. Responding organizations hiring marine technicians (Question II-1)

	hire		do not hire	
	no.	%	no.	%
industry	30	10	226	90
agencies	12	24	38	76
educational institutions	24	50	24	50

II. Responding organizations having marine technician job classification (Question II-4)

	have class		have no class	
	no.	%	no.	%
industry	12	8	134	92
agencies	3	10	28	90
educational institutions	11	26	31	74

III. Responding organizations having difficulty hiring marine technicians (Question II-6)

	have difficulty		have no difficulty	
	no.	%	no.	%
industry	15	17	72	83
agencies	1	5.5	17	94.5
educational institutions	3	9	31	91

IV. Average number of marine technicians employed by responding organizations (Question II-3)

	formally trained		nonformally trained	
	mean	median	mean	median
industry	9	3	11	4
agencies	58	28	386	7
educational institutions	18	3	13	3

EMPLOYER CONTACT WITH MARINE TECHNICIAN
TRAINING INSTUTITIONS

Survey Questions	Private Industry		Educational Institutions		Government Agencies	
	Yes	No	Yes	No	Yes	No
Find Training of These Employees Adequate	44%	56%	83%	17%	50%	50%
Recruit Graduates of Liaison Institution	8%	92%	40%	60%	5%	95%
Maintain Liaison with Training Institution	17%	83%	67%	33%	14%	86%
Have Been Contacted by Training Institution	48%	52%	40%	60%	21%	79%

Figure 6

Conclusions

In the publication Criteria for Technical Education: A Suggested Guide, The U. S. Department of Health, Education and Welfare expressed the idea generally accepted in 1968 (Ref. 8) that there was an urgent need for training technical manpower. Among the reasons given was the statement:

> The explosion of new scientific knowledge has caused changes in education so that the recently graduated scientist or engineer often has had limited laboratory experience and functions more as theoretical, diagnostic, interpretive, creative, or administrative professional than in the past. He now must delegate much of his scientific work to other skilled members of the scientific team. Thus a serious shortage of trained manpower capable of giving the technical laboratory or clinical service formerly performed by the engineer. . .has developed.

It is not surprising therefore, that Professionals-to-Technicians is frequently cited as a determinant of demand, as a measure of utilization and as a governing philosophy for the use of marine technicians. The ratio neatly packages into one measure most of the factors relevant to the assessment of demand.

Benson (Ref. 2) stated that the ratio of engineers to technicians which he saw as ranging from 3 to 1 to 6 to 1, constituted an incorrect use of manpower. The ratio should be, he felt, 3 technicians to each engineer.

Brown (Ref. 3) also refers to the 3 to 1 ratio, but indicates that such ratios should not receive as much attention as should the abilities and quality of technicians being trained. Thus, he encouraged improvement in the quality of education rather than in the quantity of marine technical personnel being produced. He added:

> This is a time for extremely wise counseling and perhaps alternate directions for some students--directions that might only be temporary.

Arguments for high (3:1) or low (1:3 to 4) ratios are at odds with the realities of historical precedent and the results of surveys which yield roughly 1:1 ratio.

There is no reason to doubt that ratios expressing the need for a greater number of trained marine technicians per highly educated scientist and professional, make some theoretical sense. However, arguments for both extremes are compelling but in our opinion more weighty on the side of the higher ratio of professionals to technicians. Aside from the arguments of prestige, flexibility, and the like, the divergent views can be briefly summarized in the following statements.

High Ratio P/T - The technician as a resource can relieve the scientist or engineer of the mundane or routine activities that are also of a highly specialized nature. However, since only a fraction of the work is of such a nature, it is reasonable to have 1 technician serve the needs of a number of scientists and engineers. Also, since the scientist and engineer are required for specific high valued purposes, when not so occupied, economics dictates that their talents should be applied to whatever task is at hand, even if below their level of competence.

Low Ratio P/T - The scientist and engineer, being highly trained, should always be used in a way that maximizes intellectual input. This implies that every scientist or engineer should have a stable of technicians for any mundane tasks that must be accomplished. Also

implied is a continuing sequence of problems or activities that can exploit the unique talent of the engineer or scientist.

In the light of these arguments and the assessment study data which show that in 1973:

> *--Industry respondents employed an average of 1 technician for every 10 professionals*
>
> *--Agencies employed an average of 2 technicians for every 15 professionals*
>
> *--Educational institutions employed an average of 1 technician for every 10 professionals*

This report agrees with Brown that this is a time for wise counseling and possible alternate directions for some students.

It has also been suggested in this section, that from an alternative viewpoint, one can think of marine technicians as a group whose activity is uniquely dependent upon the marine environment. In so doing, a new perspective of demands might result and also some new program concepts.

The classification problem, because of the absence of a clear definition of marine technician occupational clusters and career progression possibilities, has also been discussed. It has been pointed out that the difficulty with the highly general classifications is potential on-the-job training adaptation of non-marine programs to environmental peculiarities. As noted in personal correspondence with the Ocean Operations Division of a major company (C. R. Isaacs, Kennecott Exploration, Inc.):

> Our needs, we have found, can be best met by employing specific talents, such as welding and fabricating, rather than the more generalized skills developed through marine technician training programs. These basic skills are applied to specific ocean disciplines through in-house training and experience.

From consideration of all these factors (mainly qualitative in nature) it seems likely that the marine management pyramid which depends upon creative science or engineering at the apex, contains a mix of supportive degreed graduates and associates that drives the P/T ratio into the 1:1 to 1:2 range, with the marine technician best suited to provide environmentally unique and environmentally dependent support. It is frequently confusing to the picture of supply and demand, to consider marine technician training and employment as a whole. More logically, surveys should be segmented and job classifications more strictly defined and agreed upon. This implies much closer contact required with the community employers. For example, the inclusion of graduates of diving programs as technicians in calculating user P/T ratios is questionable when considering the usually small diving service companies - the diver is the staff, not the technical support. A reasonable ratio under such circumstances therefore, would be divers to diver tenders.

An article in the May 31, 1972 edition of the Washington Evening Star offers the opportunity to exercise some rough order of magnitude (ROM) calculation on the market for MT's. Sylvia Porter, a respected syndicated columnist, reported that by 1980 the estimated number of oceanographers (in the very broadest sense of the word) will expand to at least 40,000, an increase of 32,000 over the gross number available in 1968 (very optimistic even if one accepts estimates of total grads for '60-'68 and (Ref 22) applies a 6-year doubling rate as mentioned by Daubin and Mavor (Ref. 10). Ms. Porter stated that there would also be opportunities for growing numbers of technicians in the marine

specialities - to rig underwater pipelines, test underwater communication systems, develop new ways of harvesting foods and drugs from the ocean, discover new mineral deposits beneath the sea, and work on conserving the ocean's natural resources. At the modal ratio of 1 to 2 scientists per technician this would mean a technician market of 16-32,000. With the Tepadino ratio of about 25% filled by marine technology majors (Ref. this would mean 4-8,000 marine techs needed by 1980 or an average of approximately 540-900 per year based on the 9-year period from 1972-80 inclusive. This would indicate that the supply from existing MT programs could already be quite close to exceeding the demand.

Part V

RECOMMENDATIONS

The vast number of jobs expected to await formally trained marine technicians have not materialized. Relying on manpower data acknowledged to be inaccurate, institutions have rapidly entered the field of marine technician training, and have expanded existing programs. Study data indicate that enrollments in these programs will continue to increase through 1975, and that this increase may far outstrip the number of jobs available.

No indications can be considered entirely reliable, however, until data problems first noted in the Stratton Report, and still existing, are resolved. Conditions then and now have rendered it impossible to compile accurate manpower projections for marine technicians, whether formally or nonformally trained. Yet the primary concern of those involved in planning, supporting, and advising vocational training efforts must be employability of these being trained.

The following recommendations are therefore submitted.

Recommendation 1

The Interagency Committee on Marine Science and Engineering should encourage the appropriate agency to establish an office in which the following activities would be developed and maintained:

a. a national source of manpower data relating to supply and demand of marine technicians regionally and nationally, the data to be compiled and disseminated on an annual basis;

b. interagency coordination of marine technician training program sponsorship;

c. objective yet flexible criteria for decision-making regarding initial or continuing funding of marine technician training programs;

d. assistance to existing training programs in reaching a realistic assessment of their activities;

e. the means for dynamic involvement of students, educational institutions, and employers in order that the interests of all in the marine technology arena be understood and pursued in an atmosphere of mutual understanding of goals.

The collection of adequate data is so vital to the assessment of supply and demand, federal sponsorship of educational programs should be made conditional to the maintenance of adequate records.

INVEST IN IMPROVEMENT OF THE DATA BASE

Recommendation 2

Until such time as adequate manpower data are available, and until the success of existing programs can be evaluated, the Interagency Committee on Marine Science and Engineering should recommend to Sea Grant and other sponsoring agencies that:

a. requests for federal funds for existing marine technician training programs be more carefully scrutinized and evaluated by sponsoring agencies;

b. requests for federal funds for the establishment of new programs be denied, except where clearly documented manpower needs, particularly local, verified by the sponsoring agency, can be provided along with documentation showing that existing programs can not meet these needs

c. all programs receiving federal sponsorship be held more closely accountable for providing detailed employment records of program graduates.

Pursue a program development strategy which minimizes risk to the student. In the absence of better information from the user, a shortage of trained personnel is preferred to an overabundance.

LET SUPPLY LAG DEMAND

Encourage only selective types of marine technician training programs because

a. Accumulated data however incomplete, shows that supply is increasing at a much faster rate than demand.

b. Respondents were universally unenthusiastic about future opportunities.

Recommendation 3

Initiate action with prospective users, particularly industry, to create a more credible picture of demand. Since a major purpose of MTT programs

is to fill a declared need of the user, than the users, in good faith, should be willing to provide the data needs. No data--no programs!

As part of this effort, develop definitions with the help of employers for

- Marine technicians
- Marine occupations
- Marine occupation clusters

Recommendation 4

In order to alleviate placement problems of students recently trained or currently in training, and while awaiting the implementation of the above recommendations, the Interagency Committee on Marine Science and Engineering should immediately initiate a special effort to

a. identify marine-technician level jobs within the federal establishment;

b. disseminate this information to marine technician training program directors.

APPENDIXES

I MARINE TECHNICIAN TRAINING PROGRAM DIRECTOR WORKSHOPS: ATTENDEES

II MARINE TECHNICIAN TRAINING PROGRAMS

III SAMPLE MARINE TECHNICIAN TRAINING PROGRAM CURRICULUMS

IV TABLE A-IV-1. DROP-OUT/ENROLLMENT CHARACTERISTICS

V TABLE AV-1. REPRESENTATIVES SIC'S

TABLE AV-2. INDUSTRY CHARACTERISTICS

APPENDIX I

MARINE TECHNICIAN TRAINING PROGRAM
DIRECTOR WORKSHOPS: ATTENDEES

A. East Coast Workshop, May 1973

Dr. Tapan Banerjee
Southern Maine Vocational Technical Institute
Fort Road
South Portland, Maine 04106

Mrs. Matilene Berryman
Chairman
Environmental Science Department
Washington Technical Institute
4100 Connecticut Avenue, N.W.
Washington, D. C. 20008

Mr. Michael Bowling
Lenior Community College
1600 Sarey Road
Kinston, North Carolina 28501

Mr. Howard Fowler
Florida Keys Community College
Stock Island
Key West, Florida 33040

Mr. William Paul Gray
Education Programs Specialist
Division of Vocational and Technical Education
U. S. Office of Education
Department of Health, Education, and Welfare
Washington, D. C. 20202

Captain Arthur Jordan
Cape Fear Technical Insitute
411 North Front Street
Wilmington, North Carolina 28401

Mr. Andrew Korin
Occupational Education Specialist
One Dupont Circle, N. W.
Room 410
Washington, D. C. 20036

Mr. Andrew La Bonte
Coordinator of Marine Science Technical Programs
1090 N.W. North River Drive
Miami, Florida 33132

Dr. Vincent R. Liquori
Kingsborough Community College
2001 Oriental Boulevard
Brooklyn, New York 11235

Mr. Leonard Mitchell
Consultant
College of Marine Studies
University of Delaware
Newark, Delaware 19711

Mr. Thomas R. Poe
Assistant Professor of Biology
Charles County Community College
P. O. Box 910
Mitchell Road
La Plata, Maryland 20646

Dr. Walter L. Smith
Chairman
Department of Marine Science and Technology
Suffolk County Community College
533 College Road
Seldon, Long Island, New York 11784

Professor Kenneth Stibolt
Anne Arundel Community College
Arnold, Maryland 21012

Mr. Donald Workman
Welding Department
Texas State Technical Institute
Waco, Texas 76705

B. West Coast Workshop, June 1973

Dr. Gordon L. Chan
College of Marin
Kentfield, California 94904

Dr. Tom Garrison
Coordinator, Marine Studies
Orange Coast College
2701 Fairview
Costa Mesa, California 92626

Dr. Jackson B. Hargis
Assistant Dean of Instruction
Clatsop Community College
Astoria, Oregon 97103

Mr. Leonard Mitchell

Dr. John C. Serwold
Coordinator, Marine Technician Project
Shoreline Community College
Seattle, Washington 98133

Dr. Donald Smith
Seattle Central Community College
1718 Broadway
Seattle, Washington 98122

Mr. Peter A. Williams
Highline Community College
Midway, Washington 98031

APPENDIX II

MARINE TECHNICIAN TRAINING PROGRAMS

Thirty-five institutions offering programs in marine technology were identified in the course of the Assessment Study.

These institutions are listed below by state with brief descriptions of their program. Institutions visited as part of this study are indicated by a cross (+). Those that received Sea Grant funds during academic year 1973-1974 are preceded by an asterisk (*).

Arkansas

1. Southwest Technical Institute
East Camden, Arkansas 71701

Director: Charles Johnston

Program: Water and Wastewater Technology

California

+2. College of Marin
Kentfield, California 94904

Director: Dr. Gordon L. Chan

Program: Marine Technology

Objectives:
To train students for a career in marine technology with curriculum emphasis on electronic-instrumentation handling of data. An optional program in biological technology is also offered.

3. Fullerton College
Fullerton, California 92634

Coordinator: Howard Craig

Program: Oceanographic Technology

Objectives:
To enable students to transfer to four-year institutions. Shipboard and onshore work programs are offered.

4. Orange Coast College
Costa Mesa, California 92626

Coordinator: Tom S. Garrison

Program: Marine Technology

Objectives:
To prepare students for immediate employment by offering marine science core courses, support courses in physics and mathematics and general education courses.

+5. San Diego Community Colleges
City College, San Diego, California 92101
Mesa College, San Diego, California 92112
Evening College, San Diego, California 92101

Director: Robert Eberhart

Program: Marine Technology

Objectives:
To develop skills related to basic tasks needed in the marine environment.

+6. Santa Barbara City College
312 North Nopal Street
Santa Barbara, California 93109

Coordinator: Ramsey Parks

Programs: Marine Diving Technology
Marine Instrumentation Technology

Objectives:
To prepare qualified Marine Diving Technicians to meet the growing needs of industry. Through the efforts of the Marine Technology Advisory Committee, a broad curriculum has been developed to meet these needs. The curriculum is designed to give the student a basic understanding and knowledge of the marine environment and to develop the skills required of a diving technician. Also included in the curriculum are general education courses designed to increase the student's knowledge and communicative ability.

District of Columbia

*7. Washington Technical Institute
Washington, D. C. 20008

Chairman, Environmental Science Department: M. S. Berryman

Program: Marine Science Technology

Florida

+8. Florida Keys Community College
Stock Island
Key West, Florida 33040

Director: Howard G. Fowler

Programs: Aquaculture Technology
Marine Diesel Technology
Marine Propulsion Technology

Objectives:

A. The aquaculture technology program is designed to give students a broad background in biology and chemistry, as well as a specific grounding in the area of aquaculture.
B. The marine diesel technology program is designed to give career preparation in the marine diesel service area. This is a one-year program.
C. The marine propulsion technology program is designed to prepare students for jobs in service, sales, and/or promotion.

9. Gulf Coast Community College
Panama City, Florida 32401

Director: Lester Morley

Program: Marine Technology

Objectives:

To offer an AS in Marine Technology with two options in the second year: the physical option or the biological option. In addition, an AA in Pre-Oceanography is available to students who wish to transfer to a four-year program in oceanography.

+10. Miami-Dade Community College
1090 N.W. North River Drive
Miami, Florida 33132

Director: Richard Benson

Programs: Marine Electronics Technology
Marine Engineering Technology
Marine Survey Technology

Objectives:

A. To continue and to update the Marine Technician Program of the College. The education effort will be devoted to providing a two-year fundamental training program in Engineering Operations, Oceanographic Instrumentation, and Electronics, including Physical, Geological, and Engineering, and Geophysical Measurements in the ocean.
B. To continue and to update the Miami-Dade/University of Miami Diving Training Program.

Hawaii

*+11. Leeward Community College
Pearl City, Hawaii 96782

Director: T. Benson

Program: Oceanographic Technology

Objectives:
A. to train technicians in skills required to meet indicated needs of Hawaii's marine-oriented community.
B. to achieve a program flexibility that will facilitate employment at levels appropriate to the student's individual ability and inclination.

Maine

+12. Southern Maine Vocational Technical Institute
Fort Road
South Portland, Maine 04106

Director: Tapan Banerjee

Programs: Applied Marine Biology and Oceanography
Industrial Marine Science
Marine Science Technology

Objectives:
To provide students with specific skills and methods so that they will be employable as technicians upon graduation, and to provide a strong background in marine sciences and the humanities.

Maryland

13. Anne Arundel Community College
Arnold, Maryland 21012

Director: Kenneth A. Stibolt

Program: Ocean Engineering Technology

Objectives:
To offer a two-year curriculum with strong emphasis on technical subjects as a foundation for employment in ocean industry or government laboratories. Students have the option to emphasize either mechanical or electrical subjects.

14. Charles County Community College
La Plata, Maryland 20646

Coordinator: Thomas Poe

Program: Estuarine Resources Technology

Objectives:
To train in two years research assistants capable of performing a wide variety of field and laboratory functions in the estuarine and freshwater environments. The program focuses on practical field studies.

Michigan

15. Northwestern Michigan College
Travers City, Michigan 49684

Director: Captain Wheatley Hemmick

Program: Marine Biology Technology

New York

16. State University of New York Agricultural and Technical College
at Cobleskill
Cobleskill, New York 11043

Director: Walter J. Clark

Program: Fisheries and Wildlife Technology

Objectives:
To allow students the opportunity to work with conservation biologists in the field and laboratory. Required seminars provide students with an opportunity to discuss and exchange ideas with faculty and professional conservationists and to keep abreast of professional advances and career opportunities.

+17. Suffolk County Community College
533 College Road
Seldon, Long Island, New York 11784

Director: Walter L. Smith

Program: Marine Technology

Objectives:
To train post-high-school students in a two-year technology program oriented toward immediate employment in marine-related fields.

North Carolina

*+18. Cape Fear Technical Institute
411 North Front Street
Wilmington, North Carolina 28401

Director: Captain Arthur W. Jordan

Programs: Marine Diesel Mechanics
Marine Laboratory Technology
Marine Technology

Objectives:
To train young men and women to become employable aboard ships at sea and at shoreside installations in marine-oriented vocations.

19. Haywood Technical Institute
Clyde, North Carolina 28721

Director: Walter D. Rice

Program: Fisheries and Wildlife Management Technology

Objectives:
To give students an opportunity to learn the technical aspect of fisheries and wildlife management as well as basic knowledge or oral communications, business and other related subjects.

20. Lenoir Community College
Kinston, North Carolina 28501

Director: Michael Bowling

Program: Freshwater Fisheries Technology

21. Martin Technical Institute
Williamston, North Carolina 27892

Director: James A. Thompson

Program: Fisheries and Wildlife Management Technology

22. Wayne Community College
Goldsboro, North Carolina 27530

Director: Dr. Terry Humphries

Program: Fisheries and Wildlife Management Technology

Oregon

*+23. Clatsop Community College
Astoria, Oregon 97103

Director: Paul D. See

Program: Marine Technology
Oceanographic Technology

Objectives:
A. To train students to be vessel operators, such as Captains (Masters), Mates, Able Seamen, Deckhands, Engineers, and Tankermen.
B. To prepare students for examinations for US Coast Guard marine licenses: to 1,000 tons for Master; 10,000 HP Diesel for Engineers.

Rhode Island

*+24. University of Rhode Island
Kingston, Rhode Island 02881

Chairman: Dr. J. C. Sainsbury

Program: Commercial Fisheries Technology

Objectives:
To educate students for the eventual command of commercial fishing vessels, while also preparing students to enter and advance in employment in most sections of the commercial fishing industry or supporting industries.

Texas

*+25. Brazosport College
500 College Drive
Brazosport, Texas 77541

Director: E. D. Middleton

Program: Fisheries and Marine Technology

Objectives:
To train students to be vessel operators and to prepare them for US Coast Guard examinations.

26. Del Mar College
Corpus Christi, Texas 78404

Director: Dr. Jerry F. O'Donnell

Program: Marine Science Electronics Technology

Objectives:
To produce technicians trained to work in marine-related professions after two years. Transfer to a senior institution if possible.

+27. Texas State Technical Institute
Waco, Texas 76705

Director: R. V. Vann

Program: Underwater Welding Technology

Objectives:
A. To continue improvement of techniques in the use of the dry habitat chamber in Metal Inert Gas and Tungsten Inert Gas Welding.
B. To further develop instructional methods to include programmed and individualized modules.

Washington

*+28. Clover Park Education Center
Lakewood, Washington 98499

Director: John Ronning

Program: Commercial Fisherman Crewmember Training Program

Objectives:
To provide technical assistance and training to the people who man the nearly 10,000 fishing vessels licensed in the state, by providing training on a countinuing basis. The Commercial Fisherman Crewmember Training Program lasts one year.

*+29. Grays Harbor College
Aberdeen, Washington 98520

Director: John M. Smith

Program: Fisheries Technology

Objectives:
To offer students either a two-year fisheries technology course or the first two years of courses needed for a bachelor's degree in fisheries biology from universities and colleges in the Pacific Northwest. In line with this, the following objectives were outlined:

A. To develop the usefulness of the Eastern bay blam as food or bait.
B. To determine the life history of the ghost shrimp in order to discover a practical method of control.
C. To revise current courses.

*+30. Highline Community College
Midway, Washington 98301

Director: James C. Scott

Program: Underseas Technology

Objectives:
A. To prepare students for employment as underseas technicians.
B. To provide other Northwest educational institutions, government agencies, and private businesses with instruction in underseas diving techniques and safety procedures.

+31. Peninsula Community College
Port Angeles, Washington 98362

Director: R. B. Grinols

Program: Pollution Technology

Objectives:
A. To develop student proficiency in techniques of applied water chemistry.
B. To develop student proficiency in collecting, identifying, and preserving biological samples.
C. To compare and contrast polluted and nonpolluted environments on a chemical and biological basis.
D. To relate project results to the community in order to inform the public about certain critical marine problems.

*+32. Seattle Central Community College
Seattle, Washington 98122

Director: Donald W. Smith

Program: Marine Carpentry
Marine Engineering Technology

Objectives:
To provide trained personnel competent to operate and maintain marine hydrualic and diesel propulsion equipment.

*+33. Shoreline Community College
Seattle, Washington 98133

Director: John C. Serwold

Programs: Marine Biology Technology
Ocean Technology

Objectives:
To help fill the need for oceanographic and marine biology technicians by updating, improving, and further developing the marine technician programs of the College.

Samoa

*34. American Samoa Community College
Samoa

Director: David R. Lynn

Program: Commercial Fisheries Technology

Objectives:
To provide a foundation for a potentially large Samoan fishery which can supply unmet demand for 40,000 tons of fish annually, by producing skilled fishermen through a relatively formal fisheries training program. Samoan fisheries instructors are to be utilized in the program.

Mississippi

*35. Gulf Coast Technical Institute

APPENDIX III

A SAMPLE OF MARINE TECHNOLOGY TRAINING PROGRAM CURRICULUMS

A. Cape Fear Technical Institute

--Marine Technology

--Marine Laboratory Technology

--Marine Diesel Mechanics

B. Santa Barbara City College

--Marine Technology

C. Shoreline Community College

--Marine Biology Technology

--Ocean Technology

D. University of Rhode Island

--Commercial Fisheries Technology

A. Cape Fear Technical Institute

Marine Technology

9 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

First Quarter		hours per week class	lab	credit
T-ENG 101	Grammar and Composition	4	0	3
T-MAT 101	Technical Mathematics	6	0	5
T-MSC 101	Navigation	2	2	2
T-PME 101	Internal Combustion Engines and Auxiliary Equipment	1	3	2
T-MSC 111	Practical Fishing Operations	1	3	2
T-BIO 110	General Biology	3	2	3
T-MSC 121	Ship's Maintenance	0	3	1
	total:	17	13	18
T-SHI 101	Ship Experience (2 weeks): per week hours	0	40	2
				20

9 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

Second Quarter

T-ENG 102	Grammar and Composition	4	0	3
T-MAT 102	Technical Mathematics	6	0	5
T-MSC 102	Navigation	2	2	2
T-PME 102	Internal Combustion Engines and Auxiliary Equipment	1	3	2
T-MSC 112	Practical Fishing Operations	1	3	2
T-BIO 131	Marine Biology	3	2	3
T-MSC 122	Ship's Maintenance	0	3	1
	total:	17	13	18
T-SHI 102	Ship Experience (2 weeks): per week hours	0	40	2
				20

9 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

Third Quarter

T-ENG 204	Oral Communications	4	0	3
T-MAT 103	Technical Mathematics	6	0	5

		hours per week class	lab	credit
T-MSC 103	Navigation	2	2	2
T-PME	Internal Combustion Engines and Auxiliary Equipment	1	3	2
T-MSC 113	Practical Fishing Operations	1	3	2
T-BIO 132	Marine Biology	3	2	3
T-MSC 123	Ship's Maintenance	0	3	1
	total:	17	13	18
T-SHI 103	Ship Experience (2 weeks): per week hours	0	40	2
				20

6 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

Fourth Quarter

T-ENG 103	Report Writing	5	0	3
T-MAT 201	Technical Mathematics	9	0	5
T-MSC 104	Navigation and Cartography	2	2	2
T-MSC 114	Practical Fishing Operations	1	3	2
T-MSC 213	Marine Fishery Science	3	2	2
T-MSC 124	Ship's Maintenance	0	3	1
	total:	20	10	15
T-SHI 104	Ship Experience (2 weeks): per week hours	0	40	2
				17
T-SHI 109	Ship Experience Overtime (hrs. adjustment over 4-quarter period of cruises): @ 40 hours per quarter	0	160	0
				17

9 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

Fifth Quarter

T-PHY 103	Physics: Electricity	4	2	4
T-CHM 101	Introduction to Chemistry	4	2	4
T-MSC 207	Introduction to Oceanography	4	3	4
T-GEO 101	Geology	3	2	3
T-MSC 110	Scuba Diving (or T-MSC 130)			
T-MSC 130	Oceanographic Equipment (or T-MSC 110)	0	3	1
T-MSC 125	Ship's Maintenance	0	3	1
	total:	15	15	17
T-SHI 105	Ship Experience (2 weeks): per week hours	0	40	2
				19

9 WEEKS SCHOOL; 2 WEEKS SHIP-RELATES EXPERIENCES

Sixth Quarter		hours per week class	lab	credit
T-PHY 161	Physics: Properties of Matter	4	2	4
T-MSC 208	Oceanography (Chemical)	4	3	4
T-MET 101	Meteorology	3	2	3
TOELN 132	Shipboard Electronics	4	2	4
T-MSC 134	Oceancgraphic Equipment	0	3	1
T-MSC 124	Ship Maintenance	0	3	1
	total:	15	15	17
T-SHI 109	Ship Experience (2 weeks): per week hours	0	40	2
				19

9 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

Seventh Quarter

T-PHY 102	Physics: Work, Energy, Power	4	2	4
T-MSC 209	Oceanography (physical)	4	3	4
T-MSC 134	Marine Welding	2	2	2
T-ELN 133	Shipboard Electronics	4	2	4
T-MSC 132	Oceanographic Equipment	0	3	1
T-MSC 127	Ship's Maintenance	0	3	1
	total:	14	15	16
T-SHI 107	Ship Experience (2 weeks): per week hours	0	40	2
				18

6 WEEKS SCHOOL; 2 WEEKS SHIP-RELATED EXPERIENCES

Eighth Quarter

T-AHR 206	Marine Refrigeration	4	4	3
T-MSC 210	Oceanography (Instrumentation)	4	3	4
T-ELN 134	Shipboard Electronics	2	4	2
T-MAT 211	Basic Statistics	4	0	3
T-MSC 133	Oceanographic Equipment	0	3	1
T-MSC 128	Ship's Maintenance	0	2	1
	total:	14	16	14
T-SHI 108	Ship Experience (2 weeks): per week hours	0	40	2
				16
T-SHI 109	Ship Experience Overtime (hrs. adjustment over 4-quarter period of cruises): @ 40 hours per quarter	0	160	0
				16

Marine Laboratory Technology

First Year

First Quarter		hours per week class	lab	credit
T-ENG 101	Grammar and Composition	3	0	3
T-MAT 101	Technical Mathematics	5	0	5
T-BIO 110	General Biology	2	2	3
T-PHY 101	Physics: Properties of Matter	3	2	4
T-MSC 206	Introduction to Oceanography	3	0	3
		16	4	18

Second Quarter				
T-ENG 102	Grammar and Composition	3	0	3
T-MAT 102	Technical Mathematics	5	0	5
T-BIO 111	Microbiology	3	2	4
T-PHY 103	Physics: Electricity	3	2	4
T-MSC 110	Scuba Diving			
	or T-BUS 102 Typewriting	0	3	1
		14	7	17

Third Quarter				
T-ENG 103	Report Writing	3	0	3
T-MAR 103	Technical Mathematics	5	0	5
T-BIO 133	Invertebrate Zoology I	3	2	4
T-CHM 101	General Chemistry	3	2	4
T-MSC 210	Oceanography (Instrumentation)	3	2	4
		17	6	20

Second Year

Fourth Quarter				
T-ENG 204	Oral Communication	3	0	3
T-MAT 201	Technical Mathematics	5	0	5
T-ELN 127	Fundamentals of Electronics	3	2	4
T-CHM 101	Analytical Chemistry	3	2	4
T-BIO 134	Invertebrate Zoology II	3	2	4
		17	6	20

Fifth Quarter				
T-SSC 206	American Institutions	3	0	3
T-MAT 211	Basic Statistics	3	0	3
T-MSC 211	Oceanographic Techniques	3	2	3
T-GEO 101	Geology	3	0	3
T-MSC 207	Aquarium Systems	2	3	3
T-MET 101	Meteorology	2	2	3
		16	7	19

Sixth Quarter		hours per week class	lab	credit
T-MSC 100	Small Boat Handling & Engine Repair	0	3	1
T-MSC 217	Special Problem (Lab Project)	2	5	4
T-MSC 203	Marine Ecology	3	2	4
T-MSC 214	Marine Fishery Science	3	2	4
T-PJO 110	Photography, Introduction to	3	0	3
		11	12	16

Marine Diesel Mechanics

First Quarter		hours per week class	lab	credit
MDE 1101	Marine Diesel Eng. Theory & Prac.	5	10	8
MAR 1101	Applied Mathematics	5	0	5
PHY 1104	Applied Physics I	1	2	2
MEC 1121	Machine Shop Theory & Practice	2	3	3
ENG 1101	Reading Improvement	2	0	2
		15	15	20
Second Quarter				
MDE 1102	Marine Diesel Eng. Theory & Prac.	6	10	9
MAT 1123	Machinist Mathematics	5	0	5
EKC 1101	Marine Electricity	1	3	2
SFT 1104	Blueprint Reading	0	3	1
ENG 1102	Communication Skills	2	0	2
		14	16	19
Third Quarter				
MDE 1103	Marine Diesel Eng. Theory & Prac.	5	12	9
ELC 1102	Marine Electricity	1	3	2
WLD 1101	Basic Welding	1	3	2
SS 1101	Safety at Sea	1	2	2
PST 1101	Human Relations	2	0	2
		10	20	17
Fourth Quarter				
MDE 1104	Marine Diesel Eng. Theory & Prac.	5	12	9
ELC 1103	Marine Electricity	1	3	2
MEC 1122	Machine Shop Theory & Practice	0	6	2
NUS 1105	Industrial Organizations	3	0	3
		9	21	16

B. Santa Barbara City College

Marine Technology

First Semester		hours per week lecture	lab	units
MT 1	Seamanship & Small Boat Handling	2	4	3
MT 2	Basic Diving	2	4	3
IT 2	Drawing & Blueprint Reading	1	6	3
Weld 1	Technical Report Writing	1	2	1.5
*HE 1	Health Education	2	0	2
		9	19	14.5
Second Semester				
MT 3	Advance Diving	2	4	3
MT 4	Fund. of Marine Engines & Compressions	2	3	3
Weld 3	Marine Welding	1	3	2
Eng. 18B	Technical Report Writing	1	2	1.5
ES 11	Physical Oceanography	3	3	4
Bio 5	Marine Biology	2	3	3
		11	18	16.5

Students deficient in Math will be required to take Math 41 and 43.

Summer Session: MT 11 (Marine-related work experience, 1-4 units; one unit of credit per 75 hours of work).

Third Semester				
MT 5	Underwater Construction	2	4	3
Bio 11	Biological Oceanography	2	3	3
Phy 11	Technical Physics	3	3	4
Elec 10	Fundamentals of Electronics	2	3	3
MS 11	Machine Shop Operations	2	6	4
		11	19	17
Fourth Semester				
Mt 6	Underwater Operations	2	4	3
MT 7	Diving Systems	2	3	3
Phy 1	Technical Physics	3	3	4
Speech 5	Business Speech	3	0	3
*Amer Inst		3	0	3
		13	10	16

*American Institutions and Hygiene are required for the Associate in Science degree.

Students with advanced standing and above average grades may elect to take credit for independent study in MT 21-22 Research Module (1-3 units).

Recommended: MT 11, 21, and 22.

C. Shoreline Community College

Marine Biology Technology

Freshman Year		Sophomore Year	
Fall		**Fall**	
Bio 101	5	Chem Tech	6
Ocean 101	5	Bio 195	5
Photo 100	3	Elect 142	4
Elect		Engl 270	3
	13		18
Winter		**Winter**	
Zool 111	5	Chem Tech 191	6
Elect 140	4	Ocean Tech	6
Math 191	4	Elect	
Math 200	2		
Elect			
	15		12
Spring		**Spring**	
Bio 103	5	Chem Tech 192	6
Elect 141	4	Ocean Tech	6
Math 192	4	Bio 201	5
Elect	2		
	13		17

Ind Tech 102, 103, 115, 116, 160
Phys Ed 140, 100, 150
Ocean Tech 170, 171, 174
Zool 112

courses available during summer quarters:
Engl 101
Mt 101, 200
Chem 101
Bio 101
Photo 100
Ind Tech 102

Prerequisites before entry into Sophomore Year:
English 101 (or certain score)
Math 40 or 101 (or score of 60+)
Chem 101 or one year of high school chemistry

Ocean Technology

Freshman Year		Sophomore Year	
Fall		**Fall**	
Ocean 101	5	Elect 142	4
Engr T 150	5	Chem T 190	6
Phys Ed 140	1	Photo 100	3
Geol 101	5	Engl 270	3
	16		16
Winter		**Winter**	
Mt 101	4	Mt 200	2
Phys Ed 100	5	Chem T	6
Elect 140	4	Ocean T	6
Ind T	4	Elect	
	17		14
Spring		**Spring**	
Elect 141	4	Chem T 192	6
Mt 192	4	Ocean T 197	6
Ind 600	4	Bio 103	5
Engr T 155	5		17
	17		

Electives:

Ind Tech 103, 115, 116	4 credits each
Phys Ed 150	5 credits
Biol 101	5 credits
Eng Sci 200, 201	2 credits each
Ocean Tech, 170, 171	6 credits each

Courses available during Summer quarters

Engl 101	Engr 155
Math 40 or 101	Photo 100
Chem 101	Ind T 102
Geol 101	Math 200
Engr 150	Biol 102

D. University of Rhode Island

Commercial Fisheries

Freshman Year
First Semester

ENG 113	Composition	3
FMT 013	Shipboard Work I	2
FMT 118	Introduction to Commercial Fisheries	3
MTH 109	Algebra and Trigonometry	3
PEM 172	First Aid	1
REN 135	Fisheries Economics	5
		18

Second Semester

FMT 014	Shipboard Work II	1
FMT 110	Marine Technology	5
FMT 121	Fishing Gear I	3
FMT 131	Seamanship	3
SPE 101	Fundamentals of Oral Communication	3
-------	General Education Elective	3
		18

Sophomore Year
First Semester

FMT 015	Shipboard Work III	1
FMT 235	Fisheries Meteorology	2
FMT 241	Marine Engineering Technology I	4
FMT 261	Marine Electronics	3
FMT 281	Navigation I	4
FMT 351	Fish Preservation	4

Second Semester

FMT 222	Fishing Gear II	3
FMT 242	Marine Engineering Technology II	4
FMT 293	Fish Operations Practicum	1
FMT 371	Ship Technology	4
FMT 382	Navigation II	3
FMT 392	Fishing Operations	3
		18

total credits required: 72

APPENDIX IV

TABLE A-IV-1. DROP-OUT/ENROLLMENT CHARACTERISTICS

Table A-IV-1

Table A-1. ENROLLMENT IN MARINE TECHNICIAN TRAINING PROGRAMS, 1970 to 1975

educational institution	1970	1971	1972	1974		1974		1975		1970-1975
				new	/ total	new	/ total	new	/ total	increase
Cabrillo CC	10	---	--	--	--	--	--	--	---	
Cape Fear Tech. Inst.	96	145	160	200	312	250	352	300	425	343%
Charles County CC	--	15	25	40	60	80	120	100	180	1100%
Clatsop CC	28	38	41	46	70	51	80	55	87	270%
College of Marin	12	9	8	10	15	10	15	10	15	25%
Del Mar College	26	--	20	20	20	20	40	20	40	53%
Florida Keys CC	60	60	60	—	—	—	—	—	--	
Fullerton College	60	60	60	60	125-150	60	125-150	—	—	129%
Gulf Coast CC	16	17	15	18	——	19	—	20	--	
Highline CC	--	25	30	30	30	30	30	30	30	20%
Leeward CC	68	65	54	80	120	80	140	80	160	135%
Lenoir CC	18	27	25	20-25	40	20-25	40	20-25	40	125%
Miami-Dade JC	30	100	80	100	150	--	150	—	250	733%
Orange Coast College	--	--	--	20	40	20	40	20	40	
St. Cloud Tech. Inst.	--	24	24	24	24	--	--	--	--	

Table A-IV-1 (cont.)

educational institution	1970	1971	1972	1974		1974		1975		1970-1975
				new	/ total	new	/ total	new	/ total	increase
Santa Barbara City C	43	51	50	52	94	52	95	52	95	120%
Southern Maine VTI	78	77	68	100	143	100	150	--	--	92%
Southwest Tech. Inst.	19	25	128	150	150	175	175	200	200	952%
Washington Tech. Inst.	--	15	30	15	35	20	38	25	43	186%
TOTAL:	589	753	878	987	1440	989	1602	1094	1917	

Table A-IV-1 (cont.)

educational institution	1970		1971		1972		1973	1974	1975
	dropouts	graduates	dropouts	graduates	dropouts	graduates	grads	grads	grads
Cabrillo CC	10	0	--	--	--	--	--	--	--
Cape Fear Tech. Inst.	46	34	57	42	63	79	95	110	135
Charles County CC	--	--	--	--	6	10	20	40	80
Clatsop CC	4	12	9	9	11	15	18	23	23
College of Marin	4	6	3	6	3	5	6	6	6
Del Mar College	26	19	--	--	9	—	0	7	10
Florida Keys CC	20	20	20	20	15	20	--	--	--
Fullerton College	15	25	15	25	15	25	20-25	20-25	--
Gulf Coast CC	4	12	4	12	4	12	14	15	16
Highline CC	25	15	10	15	10	25	18	25	25
Leeward CC	44	0	33	—	23	—	8	10	14
Lenior CC	6	6	20	9	10	—	10	10	10
Miami-Date JC	20	10	70	30	60	20	20-30	--	--
Orange Coast College	--	--	--	11	--	16	15	15	15
St. Cloud Tech. Inst.	--	--	2	18	2	18	18	--	--
Santa Barbara City C	3	29	18	13	5	25	45	45	45
Southern Maine VTI	29	38	36	33	37	41	43	50	—
Southwest Tech. Inst.	--	--	1	24	21	107	130	1150	170
Washington Tech. Inst.	14	5	8	8	8	8	18	15	18
TOTAL	253	216	316	275	307	426	501.5	546.5	666.5

APPENDIX V

TABLE A-V-1. REPRESENTATIVE SIC'S

TABLE A-V-2. INDUSTRY CHARACTERISTICS

Table A-V-1

SIC	No. of Occurrences	Title
1021	1	metal mining-copper ore
1022	1	metal mining
1211	1	Bituminous cocu and lignite mining
1311	3	crude petroleum and natural gas extraction
1372	1	oil and gas extraction
1381	4	drilling oil and gas sources
1382	2	oil and gas fluid exportation services
1389	1	oil and gas fluid services (not eksc.)
1442	1	Construction, sand and gravel
1455	1	Kaolin and all day mining and quarrying
1499	1	Misc. nonmetalic minerals (nec.)
1541	3	General contractors, industrial building, warehouse
1621	3	Heavy construction except highway and street construction
1623	1	Water, sewer, pipelines, communication and power increase
1629	3	Heavy construction (nec.)
1731	1	Electrical work (construction)
1799	1	Special trade contractors
2077	1	Animal and marine fats and oils
2531	1	Public building and related furniture
2621	1	Paper mills
2641	1	Paper coating and glazing
2649	1	Converted paper and paperboard products
2822	1	Synthetic rubber
2911	1	Petroleum refining
3011	1	Tires and innertubes
3069	1	Leather and leather products
3079	2	Leather and leather products
3264	1	Porcelain electric supplies
3311	0	Primary metal industries
3331	1	Primary smelting and refining of copper
3339	1	Primary smelting and refining of nonferrous metals
3341	1	Secondary smelting and refining of nonferrous metals
3351	1	Rolling, drawing, and extruding of copper
3356	1	Rolling, drawing and extruding of nonferrous metal except copper
3357	1	Drawing and insulating of nonferrous wire
3362	1	Brass, bronze, copper, copper brassalloy foundary castings
3369	1	Pottery products
3424	1	Saws
3433	1	Heating equipment except electronic and warm air furnaces
3441	1	Fabricated metal structures
3443	3	Fabricated plate work
3444	1	Sheet metal work
3469	1	Metal stampings
3479	1	Coating, engraving, and allied secs.

Table A-V-1 (cont.)

3483	1	Ammunition
3489	1	Ordinance and accessories
3498	1	Fabricated pipe and fabricated pipe fittings
3499	1	Fabricated metal products
3511	2	Steam, gas, hydraulic-turbines and turbine generators
3519	2	Internal combustion engines
3531	1	Construction, machinery and equipment
3532	2	Mining machinery and equipment except oil field machinery
3534	1	Elevators and moving stairways
3536	1	Machine tools, metal cutting types
3561	1	Pumps and pumping equipment
3562	1	Ball and roller bearings
3567	1	Industrial process furnaces and ovens
3573	1	Electronic computing equipment
3583	2	Air conditioning
3599	2	Machinery except electrical
3612	2	Power distribution and speciality transformers
3613	3	Switchgear and switch board apparatus
3622	2	Industrial controls
3631	1	Household cooking equipment
3632	1	Household refrigerators and home and farm freezers
3633	2	Household laundry equipment
3639	1	Household appliances (nec)
3641	1	Electric lamps
3643	1	Current carrying devices
3644	2	Non current carrying winding devices
3648	1	Lighting equipment
3651	1	Radio and television receiving sets except communication systems
3652	2	Photographic records and prerecorded magnetic tape and equipment
3622	7	Radio and TV transmitting, signaling and determination
3671	2	Radio and TV receiving type electron tubes
3673	2	Transmitting, industrial and special purpose electron tubes
3674	2	Semiconductors and related devices
3679	4	Electronic components (nec.)
3693	1	Radiographic x-ray, fluoroscope x-ray, therapeutic x-ray and others
3711	1	Motor vehicles
3714	2	Motro vehicle parts and accessories
3721	2	Aircraft
3724	2	Aircraft engines and engine parts
3728	2	Parts and auxiliary equipment
3729	1	Parts and auxiliary equipment
3731	5	Shipbuilding and repairing
3732	2	Boatbuilding and repairing
3743	1	Railroad equipment
3761	1	Guided missilesand space vehicles
3764	1	Guided missilesand space vehicles, propulsion units and parts
3811	2	Engineering, laboratory and scientific, research instruments

Table A-V-1 (cont.)

3822	1		Automatic controls for regulating residential and commercial environments
3823	2		Industrial instruments for measurement, display and control of process
3823	1		Optical lenses and equipment
3841	1		Surgical and medical instruments
3842	1		Orthopedic, prosthetic and surgical applicances and supplies
3949	1		Sporting and athletic goods
3999	1		Manufacturing industries
4213	1		Trucking - except local
4421	1	•	Transportation to and between noncontiguous territories
4422	1	•	Coastwise territories
4454	1	•	Towing and tugboat service
4469	2	•	Water transportation services (nec.)
5093	1		Scrap and waste materials
5172	1		Petroleum products and petroleum wholesales
6711	5		Holding offices
7379	1		Computer related services (nec)
7391	4		Research/Development labs
7392	4		Management, consulting and public sectors
7394	1		Equipment rental and leasing services
7397	1		Commercial testing
7399	3		Business systems (nec)
7692	1		Welding repair
8911	8		Engineering, architecture and surveying system
8922	1		Noncommercial educational, scientific, and research organizations

•Associated with marine industry

Table A-V-2 Industry Characteristics

Activity and Reference Data / Company	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Barge Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
A-1 Industries	X	X												4M	85	(P)		
All Corp												3362, 3536				(S)		
AVCO Corp		X				X										(M)	Chas	
Arejet-Genl		X														(S)		
Amer Dredging	X											1629	4A			(P)		
Anchor Specialty	X															(P)		
Anglo-Amer. Corp	X															(P)		
Applied Marine Tech. Inc.			X			X										(P)		
Applied Oceanographics Inc.	X				X	X	X						4A			(P)		
Applied Research Assoc.		X														(P)		
Aqua Contractors & Oceanographics	X			X	X											(P)		
Aquarand Inc.			X			X										(P)		
Aquatic Contractors & Engineers	X			X												(P)		
Aquatic Research Institute			X			X		X								(P)	Q	
Arctec Inc.			X					X								(P)		Hire regular techs & train for marine—indicates lack of knowledge, re MT programs
Argo Transdata Co.		X														(P)		
Arinc Research Corp.		X						X								(P)		
Atlantic, Gulf & Pacific Co.	X		X			X		X								(P)		
Atlantis Inc.	X															(P)		
Automation Industries Inc.		X														(M)		
Avondale Shipyards Inc.	X												4A			(S)		Sub Ogden Corp
Baldt Anchor & Chain Div.	X		X									1541,1621	4A			(S)		
Bechtel Marine Dept.	X		X					X				8911				(M)		
Beuthes, Inc.	X		X			X		X								(P)		
Bevog Corp.	X		X						X							(P)		
Bio-Dynamics Inc.			X			X						8911;6711 3823;41, 42;2621		20M	585	(M)		
Bolt, Beranek & Newman Inc.		X	X			X							4A	19M	520	(P) (M)	Q	
BARINCO			X													(P)		
Bossert Mfg'ing Corp.	X												4A B			(M)		
Boucher-Lewis Precision Models	X															(P)		

Company / Activity and Reference Data	Construction, Maintenance and Repair	Deep Submersible Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contracts	Remarks
J. E. Bowker Assoc., Inc.		X	X		X				X				4A	200K	3000	(P) (S) (P)	Q Chm	
Braincon Corp.		X	X															
C. F. Braun & Co.		X	X															
Brait Engineering Inc.			X	X		X							4A	634K	2300	(P) (P) (S)		
Brooke Marine Ltd.		X	X		X	X												
Brown & Root, Inc.	X		X										4A			(I) (M)		
Brown Equipt. & Service	X		X															
Brunswick Corp.	X																	
Bureau de Rech Geol & Miners	X					X							4A			(P) (S)		Div. Cooper Ind.
Burtec Co. Inc.	X					X										(S)		Div. of CBS
CB/Southern	X					X							4A			(S)		Div. of Comb Eng.
CBS Labs		X																
C-E NATCO	X	X																
COMEX	X	X		X		X		X								(S)		Sub Oceaneering
Calif Divers Inc.	X																	
Central Plastics Distrib	X																	
A. B. Chance Co.	X																	
Chippewa Outfitters Divers	X			X		X										(P)		
Coast Eng'ing Co			X			X												
CZ Resources Corp.		X																
Columbia Research Corp		X						X										
Col. Univ. Geophys. Field Station			X			X												
Com/Code Corp	X																	
Commercial Divers Inc.	X		X	X		X	X	X	X									
Commercial Eng'ing Corp.		X																
Computer Applications Inc.		X	X															
Computer Sciences Corp.		X														(N)		
Computing Devices of Canada Inc.	X					X												
Continental Shelf Data Systems			X			X												
Crandall Dry-Dock Engineers, Inc.		X	X															
CROUZET		X	X															
Cushing & Nordstrom, Inc.		X																
												3264,3613 3644,4213	B	95M	575	(P) (P)		Div. Amsedo & Ivey
													4A			(P)	Q	
																(F)	T	
																(P)		

Company \ Activity and Reference Data	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Dade Drydock, Corp.	X											8911		15M	920			2PO-73 (shoreline)
Dames & Moore		X				X												
Dana Point Marine Lab			X			X		X										
Arthur D. Bardon Inc.		X	X													(P)	Q	
Basspit Peres Marine Divers Inc.	X			X												(P)	T	
James E. Dean Marine Divers	X			X			X									(P)	T	Graduates of 3-month diving school program
Deep Sea Ventures Inc.			X								X							
Delco Electronics		X	X			X			X					3A				Div. of Gen Mtrs
Dillingham Corp.	X	X		X		X								4A		(M)		
Diversified Marine Corp	X						X					1541,1621 5721,4454 5172,6711						
Dixie Manuf'ing Corp	X																	
C. G. Doris	X	X		X		X				X								
Drave Corp.	X	X	X										4A	42M	8896	(M)		
Drave Ocean Structures Inc.	X																	Sub of Dravo Corp
Dynamics Research Corp		X										7391,7392 3662,3679	X	11M	521X			
EG & G. Inc.		X			X	X						3832	4A			(M)	Chan	C
Ecoforum Inc.			X															
Economy Mf'ing Co.	X																	
Elsytec Inc.		X																
Enesa Res & Dev		X	X															
Englehard Min & Chem	X															(M)	Q	
Engineering Science Inc.			X			X								8M	300			
Enviresearch Corp.	X					X		X										
Environmental Devices Corp.		X	X			X							X					
Environmental Eng'ing Lab		X																
Environmental Research Int'l			X															
Erosion Control			X															
Excelco Dev.	X	X																
Explo Contractors	X																	
Faslun Design & Development Co		X	X														Q	
Fluor Ocean Services Inc.	X		X							X						(S)	T	Sub of Fluor Corp 81-72; 85-70

Activity and Reference Data / Company	Construction, Maintenance and Repair	Deep Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Boell & Vastenburg Co.	X		X													(P)		
Christopher J. Foster		X	X													(P)		
Friede & Goldman Inc.			X															
Gatis Construction Corp.	X																	
General Electric Co.		X	X													(M)		
General Motors Corp.	X									Sub						(M)	Chan	
General Oceanographics Inc.		X				X				Sub			A					
General Oceans Corp.	X	X														(S)		Sub Texas Inst
Geophysical Services Inc.			X			X												
Gibbs & Cox Inc.		X	X															
Gibbs & Hill Inc.		X	X															
Global Marine Inc.		X	X			X							4A	60M	1000	(M)	Chan	1b-72
Goodyear Tire & Rubber Co.	X															(M)		
Gray Tech Industries	X	X	X														C	
R. M. Greene & Assoc.		X	X										A					
Gulfport Shipbuilding Corp.	X	X	X										3A					
Gunderson Inc.	X	X	X										4A					
Hahn & Clay	X											3599		8M	200		OCT	Sub of Halliburton
Halliburton Serv.	X						X					3731,3732						Draftsmen 2 yrs exp & v yrs college — OJT Marine
Halter Marine Services	X	X											X			(P)	T	
J. J. Henry Co.	X	X														(P)		
Harsent-G. E. M.			X			X										(P)		
Hittman Assoc. Inc.			X	X													T	Do not hire MEs but hire draftsmen and give OJT
Hood-Willamette Constructors	X							X										P/T ratio 1/1-1/3
Hydronautics, Inc.			X	X				X				8911,3922				(P)	O,T,V	JV Sub Hood & Willamette
Hydrospace Res. Corp.			X	X				X	X								Chan	
Hydrotech				X				X	X	Sub						(F)	Chan	
Hydrotech Services Corp.	X																	Sub of Hydrotech
Hydrotronics Co. IONRIC		X	X															

Company / Activity and Reference Data	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Infinity, Ltd			X			X												
Ingram Contractors Ltd	X											4421,4422						
Integrated Science Corp			X															
Interand Corp		X	X					X									T	Do not hire HT's
Interstate Elec.		X											4A				Q	
International Oceanographic Co			X			X												
International Search, Inc.			X															
International Underwater Contr	X			X												(P)		18-70
J & J Marine Diving Co. Inc.	X		X	X	X		X	X								(P)	T Q	Schools not practical. Divers trained 3-4 mos accredited comm'l diving school
J-Tec Assoc.		X	X														T	
Jakus Assoc.	X	X	X				X											
Judith Joys	X		X	X	X	X	X	X										
Kay & Assoc.			X									1021,1211 3331,3351 6711						
Kennecott Exploration Inc.			X			X							4A			(S)		Sub Kennecott Copper
Kentron Hawaii		X			X					Sub						(P)		
Norm Ketchman Marine Divers			X	X														
The John D. Kettle Corp.		X																
Klein Assoc.			X		X	X												
Korkut Eng's			X															
Kornfeld Int'l			X			X						1311						
James S. Krogen & Co.		X	X															
LTV Research Ctr.			X													(S)		Sub of LTV(s)
Lamont-Doherty Geological			X			X												
Lindbergh & Hammer Assoc.	X																	
LTV Inc.			X													(M)	Chan	
A. D. Little			X										4A	49	1544	(M)		
Litton Ind.			X													(M)	Chan	
CALAC		X	X			X		X		X							Chan Q	Sub of LAC
LMSC		X								Sub							Chan	Sub of LAC
E. J. Longyear Co	X											1799,3532	4A					
MPR Assoc		X	X															
Machine Component Corp.	X	X																

Activity and Reference Data / Company	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Robert E. Yacy																		
Makai Ramos																		
Kampoua Ship-building Co.																		
Marine Barriers Inc																(F)		
Marine Contracting International																(F)		
Marine Design Co.																(F)		
Marine Electronic Equipment Inc.																(F)	Q	
Marine Eng'ing Systems Inc.																(S)		Sub of MAREX (S)
Marine Exp'mntl Services																(F)		
Marine Modules Inc.																(M)		
Marine Resources Inc.																		
Maritime Eng'ing Co.																		
Markey Machinery Co.																		
Rudolph F. Matzer & Assoc.																		
McClelland Eng'ns Inc.																(S)		Sub Murphy Pacific
Measurement Analysts Corp.																		
Merritt Div Miami Shipyards Corp													4A			(T)		
Michel Leclerc Miller Brainard Assoc.																		
Mobil Electronics Modern Mgmt Molecular Energy Corp																		
Morris Guralnick Assoc.																		
Murphey Pacific Marine Salvage														25	250	(P)		
Nashville Bridge																(P)		
National Res. Center																		
A. L. Nelson																		
New England Divers Inc.																(?)	?	Don't hire people because they have been to school — Diver trained electronics & mechanics on surface.

Activity and Reference Data / Company	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Bichum & Spaulding Assoc.		X	X					X								(P) (M)	Q Chas	
Northrop Corp.																		
Ocean Data Equip Corp		X						X				671;3811 3729;21; 3679;62						
Ocean Data Systems Inc..			X	X		X												
Ocean Energy Inc.			X	X				X					A					
Ocean Engineering Co.			X															
Ocean Instruments	X																	
Ocean Oil Int'nl Eng'ing Corp				X				X								(P)		
Ocean Research Corp				X														
Ocean Resources Inc.						X							4A			(P)		
Ocean Routes Inc.				X														
Ocean Science Capital Corp				X													Chas	
Ocean Science & Engineering				X	X	X				X	X	1629;3731 8911;9511	4A	50M	350	(M) (S)	Union	Union Carb. 71-72; 68-70 Send trainees to Ocon Coast Sch plus 3-4 mos. welding & mechanical 18-72 Hire 3rd mates to work on drill ships
Ocean Systems Inc.				X	X			X	X	X	Sub							
Oceaneering Services Co.				X	X	X		X	X									
The Offshore Co.				X									4A	89M	3500	(M)	T	
Offshore Technology Corp				X				X										
Ogden Technology Labs				X	X							7397		5M	200	(M)		
OKI				X	X			X										
Pacific Instrumentation				X	X	X	X											
Pacific Submersibles				X														
Panoramic Studies				X														
Parke Math Labs				X	X			X										
Parker Sed. Co.				X	X													
Pelagics Inc				X	X													
Pa. Res Assoc				X	X													
Peter & Assoc				X														
Phoenix Products Co.	X											26-1,49; 3469,99; 3567,3648	3A	3M	110	(M)		Hire 3rd mates to work on drill ships

Activity and Reference Data / Company	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Characte	Remarks
Pioneer Eng'ing & Mfg Co.	X	X						X				8911;7379; 99;3369; 3441;3544 45,59;3799	4A	15M	1100			
Fort Eng'ing																		
Services Corp.	X				X				X									
Poseidon Sci		X	X			X		X										
Potomac Res		X	X															
Potter & McArthur		X	X										A					
Power Applic. Inc.			X											18M	490			
Preformed Line Products Co.			X					X										
Tresearch Inc.			X															
REMCO Marine			X			X												
Rader & Assoc			X															
Radian Corp			X					X					X				Chan C	
Ramsay Eng'ing			X															
Raytheon Co			X			X		X					4A	30M	1600	(M) (S) (M)		Sub of RCA
RCA Service			X			X												
Reading & Bates												1311;1381						
Research Triangle Inst			X					X										
Rhombic Corp			X															
Robert Taggart			X			X							A			(P)		
Roland Marine			X															
M. Rosenblatt					X	X	X		X									
S. W. Rouse				X														
San Pedro Boat Works			X		X				X									
Sanders & Thomas																		
Santa Fe Drilling			X										4A			(S)		Sub of Santa Fe Int'l
Santa Fe Int'l Corp			X	X									4A			(M)		
Scholler & Allen			X															
Hans Udo Von Schultz			X		X													
Science Eng'ing Assoc.			X			X												
SIO				X														
Seafloor Contractors			X															
Sea Hole Int'l			X															
Seatech Corp.			X															
Sea Sciences Corp																		
Seonics			X															

Company \ Activity and Reference Data	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Servo/Tech Corp		X																
Simplex Wire & Cable Co.	X												4A					
Simrad Inc.	X																	
Sippican Corp.		X	X					X					4A					
Skyline Products	X												3A					
J. T. Slocomb	X												2A					
Southern Mach & Tool	X												X					
Special Offshore Services	X								X									
Speciality Ships Unlimited		X																
Sperry Rand Co.		X											4A			(M)	T	Marine Services Eng'r. AA not necessary. Electronics background—OJT
Spincraft Inc.	X																	
Starrett Assoc.			X															
State Boat Corp.			X		X				X	X						(F)		
R. A. Stearns	X	X	X															
Steelwater Corp.	X	X	X	X	X	X		X										
Stevens Tubing	X												2A					
Submarine Eng'ing Assoc.		X	X			X										(P)	G	B1-72; B1-70
Sub-sea Systems		X															Chan	Sub ONECO B1-72; B3-70; H2-73
Sun Ship	X									Sub								Sub of SUNOCO
Swann Hydraulics		X						X										
Synthatron Corp		X				X		X								(M)	T Chan	No marine techs
TRC		X																
TRW Sys.			X															
Tacoma Boat Building			X									3519;3731	4A	20M	800			
Robert Taggart			X															Sub of Brown & Root B2-72; H3-73
Taylor Diving & Salvage	X		X	X	X												Q	
Texas Marine & Ind'l Sup	X																	
Technology Serv Inc.			X															
Tech Science Industries			X															
Texas Instr.			X			X				X						(M)		
Teledyne Brown Eng'ing		X	X			X		X					4A				Chan	Sub Teledyne Inc.
Teledyne Geotech	X	X	X			X												
Tidewater Marine Service	X					X			X			4469		59.9M	1600		T Q	Marine Techs—Draftsmen Hire 2:1 w/degree—may lead men B.S.
R. M. Tiedemann		X	X	X	X	X		X										

Company / Activity and Reference Date	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	SIC	Assets	Sales	Employment	Affiliation	Contracts	Remarks
Todd Ship	X X		X X	X	X	X	X	X	X	X			4A	200M	6000			
TRACOR/W.S Trident Labs													2A					
Triton Eng'ing & Constr.	X	X		X	X													
Undersea Eng'ing Inc.				X				X										
Undersea Enterprises	X			X	X	X	X											
Undersea Research Ltd.			X															
Undersea Systems Inc. — N. Y.	X			X	X	X	X											
Undersea Systems Inc. — Va.	X	X				X												
Underwater Clean & Maint.	X			X														
Underwater Eng'ing Inc.		X	X					X										
Underwater Technics Inc.	X		X		X								3A	10M	325		Q T	Do not hire MT's as such — Degree not req'd P/T ratio 10/1
Vector Cable	X		X									3357 7391,7392 8911					T C	No marine techs.
Vitro Corp		X	X			X		X						1.2M	48			
WAPORA		X	X															
Walter Dorwin Teague Inc.		X	X														T	No marine techs.
Welding & Steel Fab		X															Chm	
Western Geophys.	X		X		X	X				X							Chm	Sub of Fluor
WODECO	X					X											C	
Westinghouse		X	X															
Wheeler Ind.		X																
World Wide Divers	X		X	X	X				X			1398,1623		65M	2000	(M)		Sub of Oceaneering Intl B2-70
Zapata-Offshore	X					X												
Wigsing United Geophys	X		X	X	X	X				X								Sub Bendix
Deep Six Salvage				X	X											(P)		
Int'l Hydrodynamics					X													
Int'l Underwater Research				X	X		X											
Logan Diving & Salvage				X	X													
North Sea Diving Services				X												(P)	T, C	Marine Tech Divers—3 month course, Draftsmen—Civil Eng.

Company \ Activity and Reference Data	Construction, Maintenance and Repair	Design Engineering Services	Marine Ocean Engineering	Diving Services	Search, Recovery and Salvage	Survey and Exploration Services	Underwater Photography	Testing and Evaluation	Vessel and Boats Lease and Charter	Ship Operator	Ocean Operations	EIC	Assets	Sales	Employment	Affiliation	Contacts	Remarks
Underwater Serv. Association				X				X	X									
ORE Inc.			X			X												
Videospection					X	X	X									(P)		
Bag'ing Ltd					X	X		X	X									1PO-73 (shore)
Vast Inc.						X				X								
Alpine Geo																	O	
Intersea Res Corp																	Q	
Aquatic Sci Inc																(M)	Q	
Phila Resin																	Q	
Batelle																(P)	Q	
Geco Sales Corp						X												Sun DECCA Surv.Ltd
Decca Survey																	T, Q	Sub of Union Carb Formal Ed &
Donsea Farms																(M)	Q	OJT or Practical Exp instead of
ITT-Hydrosp.						X										(P)	Q	AA-many still don't know how to
Seismic Explor Intl.																		work in envt despite education:
GCRL																	T	Prof/Tech ratio-3/2
Aquarium Sys																	T	Hire Marine Tech Draftsmen
Western Glass Corp	X								X	X								either AA or traineeships (OJT)
Perry Submarine				X												(M)	Q	Div Perry Oceanographers P/T
Int'l Nickel																		ratio 1/8 B2-72 B1-72
Ala Drydock & Shipbuilding	X																	1PO-73 (shore)
Willamette Iron & Steel	X																Q	
Dynametric, Inc.						X											Q	
Seismograph Service Corp.		X															Q	
Bendix Oceanographic Services, Inc.									X								Q	
C. R. Cushing & Co					X												Q	
Oceaneering Int'l																	Q	
AMF																	Q	
Petty Geophys																	Q	
Biospherics, Inc																	Q	

Legend

Assets

4A over	$1,000,000
3A over	500,000
2A over	300,000
A over	100,000
B	>50,000
	>25,000
	>10,000
	<10,000

Affiliation

P - Parent
S - Subsidiary
M - Multi-divisional Corp

Contacts

Chan - contacted by Chan when doing Reference 5, 6, and 7
Q - Questionnaire contact (this study)
T - Telephone contact (this study)
V - Visit (this study)

Remarks

Hiring history when available, e.g.,
2PO-73 (shoreline) = 2 Physical Oceanographers Techs hired 1973 for Shoreline CC.

1B-72 = 1 Marine Biologist hire 1972.

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